Essays on Bangalore

VOL. 2

Convenors

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KSCST

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PREFACE

Bangalore was the fastest growing city in India in the 1970's. But, before this fact become generally known, two scholars had set out to study the structure of this emerging metropolis. Prof. V.L.S. Prakasa Rao and V.K. Tewari undertook a meticulous study that yeilded a veritable gold mine of data. [1] This study has been the main inspiration for the essays that follow, which are grouped into four parts.

As an earlier review pointed out, there was a great deal more that could have been gleaned from the data provided by Professor Prakasa Rao and Tewari. This is well brought out in the study of slums in Bangalore by Dr. H. Ramachandran. Also, if the data was to be of immediate use to the Policy maker, there were several other aspects that needed examination. The essays that follow may not succeed in completing this task, but they have succeeded in taking a small step forward. Thus, the study of the late Dr. Ramachandra Rao has many suggestions that will help rid the city of the mosquito menace. The study of firewood and charcoal by Prof. Amulya Reddy and Mr. Sudhakar Reddy also pose sharply the choices that face policy makers. The study of Dr. Anna Mani on Bangalore's climate makes certain points about architectural styles that will need to be taken into accounts in any future master plan for the orderly growth of Bangalore. This is true of the points in many of the other essays.

There are also areas of non–clarity.

Dr. Ramachandra Rao would like a reduction in the number of tanks in Bangalore to control mosquitoes; Dr. D. K. Subramanian would like more tanks to harvest rain to augment the city's water supply. These are areas that require further study.

Policy makers have been concerned with the growth of Bangalore. In this context, one should be careful in drawing policy implications from these essays. While several authors suggest ways of improving quality of life in the city, and even suggest certain levels of investment, it does not follow that these investments must necessarily be made. A hundred crores spent on Bangalore has to be seen against a hundred crores spent on making life better in other cities in Karnataka. If Raichur, Mysore, Hubli, Mangalore and so on become more attractive, it may be the best way of slowing down the growth of Bangalore. An investment on cities should also be assessed against the alternative of improving the quality of life in villages. This is an exercise that these essays have not undertaken.

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1. V. L. S. Prakasa Rao and V. K. Tewari, 'The Structure of an Indian Metropolis' : A study of Bangalore', Allied Publications, New Delhi, 1980.

It has also to be recognized that there are other factors that would influence urban growth in Karnataka. If, for instance, the railways were to construct broad-gauge lines from Mysore to Miraj, from Mangalore, Hassan, Shimoga to Raichur and Gulbarga, it would make a very basic difference to the entire pattern of economic development of Karnataka. A great deal of the more positive aspects of development in neighbouring Andhra Pradesh can be attributed to a good rail network.

In short, these essays show how much more needs to be done to develop a coherent set of policies for urban growth in Karnataka. If they result in stimulating further work, they will have served their purpose.

Vinod Vyasulu
Amulya Kumar N. Reddy

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The participants in the two seminars held in June 1983 and May 1984 made many useful comments which the authors have taken into account in revising their papers.

Of course, errors and opinions are those of the authors, the organization is the responsibility of the Convenors, and the credit should go to the KSCST.

Vinod Vyasulu
Amulya Kumar N. Reddy
(Convenors)

A STUDY OF THE CLIMATE OF BANGALORE

A. MANI*

1. Introduction

Bangalore has often been referred to in the past as the 'air-conditioned city of South India'. With little or no rain and the sky fully covered with low clouds, and a fresh breeze, with temperatures of the order of 21°-24°C, the morning hours during June to September are the most pleasant of times in the year. The period June to September was therefore considered the 'season' in Bangalore, when visitors from the plains used to flock to it to enjoy its salubrious climate.

The attempt in this paper is to examine whether there has been a change in the climate of Bangalore during the last one hundred years and whether the growth and development of Bangalore during the last 40 years has had any adverse effects on its climate or microclimate.

The paper begins with a general account of the climate of Bangalore, based on over 100 years of data. These data are next examined to see if any changes in climate have occured during 1875–1980. The effect of urbanisation and industrialization in the climate of Bangalore is next examined and the paper describes the results of a study of the microclimate of the city carried out in 1977. Further analysis of existing data and additional investigations on the changes in the microclimate of the city are necessary, if we are to arrive at a better understanding of the impact of human activities on the parameters determining climate and take effective steps to prevent further deterioration of the local climate by unplanned industrial and urban activities within the greater city of Bangalore.

2. Data Sources

Bangalore is among the few fortunate cities in India with uninterrupted records of meteorological data for over 100 years. The Bangalore Central Observatory was established on 1 November 1867 at Bowring Hospital, Bangalore, as a result of a recommendation by the Asiatic Society of Bengal, formed in 1784, for the advancement of sciences in Asia. Regular observations were taken at 10, 16 and 22 hours daily from 14th July 1868. The observatory was shifted in 1892 to the Central College Compound, as a result of the untiring efforts and keen interest taken in it by Prof. Cook of Central College, Bangalore, who became its first Director and the first Meteorologist to the Government of Mysore. He was also responsible for persuading the Government of Mysore to have the present building for the Central Observatory

* *Raman Research Institute, Bangalore: 560080.*

constructed in 1893, on the model of the Alipore Observatory in Calcutta. The Central Observatory, which was transferred to the newly established Mysore State Meteorological Department in 1893, was taken over by the India Meteorological Department in 1951, after the merger of the State of Mysore in India.

The second observatory in Bangalore was established at the Airport in September 1947. Two more observatories were added at the Agricultural College, Hebbal, now the University of Agricultural Sciences, and at the Indian Air Force Station at Yelahanka. Data from all the four observatories have been used in this study, as well as those from the temporary observatory operated from 1977 to 1980, at the Raman Research Institute. The results of a micro-climatological study made by the author of heat islands in Bangalore in 1977 are also included.

Locations for meteorological observations are invariably chosen so as to be free from the immediate influence of trees and buildings, and to give meteorological data which are representative of the surrounding conditions. A climatological station is located at places where the exposure will remain unchanged over a long period, so that long term changes, if any, in the global climate can be detected. All 4 observatories in Bangalore are therefore located in comparatively open areas and do not represent conditions within the city.

3. The Climate of Bangalore – A General Survey

Bangalore, located at the centre of the South Indian peninsula, equidistant from both the eastern and western coast, and at an elevation of about 1000m above mean sea level, is well known for its equable climate. According to Koppen's broad climate classification, the climate of Banagalore can be classed as the Tropical Monsoon Plateau type (Krishna Rao and Ramachadra Iyer, 1951).

The four main seasons are:

1. the cold weather season, from December to February;
2. the hot weather season, from March to May;
3. the south west monsoon season, from June to September; and
4. the north east monsoon season, from October to November.

The cold weather season is a period of generally fine cool weather, with mainly clear blue skies and a diurnal range of temperature of 10 to 14°C. It is a period of very little or no rainfall, the mean rainfall amount being only about 10mm.

The hot weather season begins in March, with temperatures rapidly rising to reach the maximum of about 33.5°C in April–May. March is a dry month with low humidity. April and May are months of considerable thunderstorm activity and an average rainfall of about 160mm, most of which fall in May.

The south-west monsoon season is a moist, cloudy and rainy period, with a total seasonal rainfall of about 490mm. September is the rainiest month with 143mm of rainfall. It is also a period of fairly strong and steady winds, blowing from the southwest to west.

The northeast monsoon season is also a moist and rainy period, but with slightly less clouding. Winds are weaker and blow from ENE to NE. The change in wind direction from WSM to ENE between September and early October is very characterstic.

The main features of the climate of Bangalore are the agreeable range of temperatures, from 33°C in April to 14°C in January, and the two rainy seasons June to September and October to November, coming one after the other but with opposite wind regimes, corresponding to the southwest and northeast monsoons. The marked thunderstorm activity with occasional hail storms and squalls in April-May and September to October are also typical. Of the annaual rainfall of 844mm, a little more than half occurs during the south-west monsoon period and about a quarter in the north-east monsoon period. Appreciable rainfall also occurs in April–May. Two other important features are the predominant low clouding and the more or less steady temperatures with small diurnal variation during the whole monsoon season June to October and the early morning dew and mist or fog during the months October to February.

Table I gives the climatological data based on 60 years of observations from 1881–1940 at the Bangalore Central Observatory (Lat. 12°58'N, long. 77°35'E, 916 metres above mean sea level). Similar data based on 30 years of observations from 1931 to 1960 are given in Table II. Data for 3 years from 1977–1980, taken at the Raman Research Institute, Bangalore with corresponding data taken at the Central Observatory, Bangalore, are given in Table III.

The monthly mean maximum and minimum temperatures, the diurnal range of temperatures, the monthly mean relative humidity and rainfall, given in Table I are illustrated in Figure 1.

3.1 Temperature : The data given in the 3 Tables for the three periods, 1881–1940, 1931–60 and 1977–1980, are basically similar. The slight differences observed will be discussed in Section 4. April is seen to be the warmest month, with a mean temperature of about 27.1°C, a mean daily maximum of 33.6°C and a mean monthly highest maximum temperature of 36.2°C (Table I).

December is the coldest month with a mean temperature of 20°C, but January has the lowest daily minimum of 14°C and the mean monthly lowest minimum temperature of 11°C. The last week of December and the first week of January are the coldest periods of the year. The highest temperature recorded in 80 years was 38.9°C in May 1931 and the lowest temperature recorded was 7.8°C in January 1884 (Table I).

The annual range of the monthly mean temperature is only about 7°C. The annual range of the mean daily maximum temperature is 8°C and of the mean daily minimum temperature is 6.5°C. The mean of the extreme annual range of temperature i. e. of the difference between the highest and lowest temperature recorded in a year is about 25°C. This means that, in an average year, one may expect a range of 25°C between the highest and lowest temperatures recorded in the year. This range varies between 22° and 27°C in individual years.

A remarkable feature of the mean monthly temperature is the uniform steady temperatures observed for as long as 4 months from July to October, with 27.6°C as the daily maximum temperature and 18.5°C as the daily minimum temperature. The mean daily temperature is 23.1°C, the variation during the four months being only 0.3°C (Table I).

Similarly during cold and hot weather seasons, the monthly mean temperatures are remarkably stable, with a mean value of 20.3°C for the two months December and January and a mean value of 26.9°C for the two months April – May. This remarkable stability is illustrated in Fig. 2 (a), in which the month–to–month variations of maximum, minimum and mean temperatures are shown, based on 5–day normals. It will be seen that the warmest days occur in the last week of April and the coldest in the first or second week of January. The highest daily maximum occurs in the first two weeks of April, while the highest daily minimum temperature occurs towards the end of April and the beginning of May. There is a steep rise in temperature from about the middle of January to the beginning of March and a slightly less rapid rise later upto the end of April, after which there is a slow rate of fall upto the middle of May and a more rapid rate of fall up to the middle of June. From the middle of June to the end of October, a long period of four and half months, the day–to–day variation is insignificant. There is slight rise of temperature from the middle of September to the beginning of October, in the transition period between the southwest and northeast monsoon seasons.

After the end of October there is a fairly rapid fall of temperature till the middle of Jaunary. There are some differences in the variation of the daily maximum and minimum temperatures. From May to the middle of October, the daily minimum has a variation of only about 2°C between 20°C and 18°C, while the daily maximum temperature has a variation of 5.5°C between 33°C and 27°C. The steepest fall is 5°C between the beginnig of May and the middle of June. Between the last week of October and the middle of January, there is a steep fall of the daily miniumm temperature by 4°C from 18°C to 14°C. During the same period, the daily maximum temperature falls only by 2°C from 27.5°C to 25.5°C (Table I).

The monthly mean diurnal range of temperature is maximum (about 15°C) in February – March, when the sky is generally clear or lightly clouded and the air is least humid. It is minimum (about 9°C) in July–August when the sky is nearly over cast and the air is very moist. The variation of the diurnal range throughout

the year, worked out from the 5 day normals of maximum temperatures, is shown in the curve in Figure 2(b). It is seen that the largest diurnal range occurs from the second week of February to the middle of March and the smallest range in the middle of July. The diurnal range is within one degree the same (about 9°C) from the middle of June to the end of September.

The maximum temperature of the day occurs at about 3 p.m. local time (*i.e.* 1521 hours IST) in all the months. The minimum tempeature of the day occurs at about 6 a.m. local time, except from May to July when it occurs about an hour or so earlier. The temperature at 9.30 a.m. and 9 p.m. local time is the mean temperature of a normal day within half a degree celsius. The highest temperature of the year occurs at about 3 p.m. in April and the lowest at about 6 a.m. in January. It is interesting to note that the whole annual range of temperature occurs within the first four months of the year.

The mean wet bulb temperature varies from 21.7°C in May to 16.1°C in January. It is steady at 20.5°C during all the 3 months July to September (Table I). The wet bulb temperature increases most rapidly between March and April and falls sharply between October and December. The highest wet bulb temperature in the year occurs at about 2 p.m. in May and the lowest at about 6 a.m. in January. The diurnal variation in wet bulb temperature is about 1.7°C. during June to September and about 1.4°C during the other months of the year. The maximum during the day occurs at about 3 p.m. and the minimum at about 6 a.m. Wet bulb temperatures have been recorded as an index of comfort or discomfort of climatic conditions ; and with wet bulb temperatures above 25°C continuous hard work is supposed to be difficult. At Bangalore, since wet bulb temperatures do not exceed 22°C, the climate may be regarded as comfortable for hard work throughout the year. The comfort parameters are discussed in detail in Section 5.

3.2 Humidity : Monthly means of relative humidity are shown in Table I. The highest mean relative humidity of 75 to 76 percent occurs during July to October and the lowest mean relative humidity of 46 percent in March. There is a rapid fall in relative humidity from December to March, the decrease being most rapid between January and February (Fig. 1b). There is a sharp rise between March and June, the increase being most rapid between May and June. Relative humidity has a fairly large diurnal range. The maximum relative humidity during the day occurs at about 6 a.m. and the minimum at about 3 p.m. The diurnal range is highest, 39 to 40 percent, from February to April when the air is dry, and lowest from July to October, 24 to 25 percent, when the air is moist. The lowest relative humidity in the year (28 percent) occurs between 3 and 4 p.m. in March and highest (87 percent) at about 6 a.m. during August to October. Relative humidity as low as 4 to 5 per cent may someties occur in the afternoon hours in March and relative humidity as high as 100 per cent can occur during the rains and in the late night and early morning from October to February when dew deposition or fog or mist occurs.

3.3 Sunshine : The largest number of hours of bright sunshine (9.5 hours) occurs in February–March. The number of sunshine hours decreases in later months reaching a minimum of 3.8 hours in June and increases later. The decrease in the sunshine hours between May and June by about 3.9 hours is the most marked (Table-1)

3.4 Rainfall : Information on the rainfall of Bangalore based on 60 year data from 1881 to 1950 is given in Table IV.

The mean annual rainfall is 844 mm and the mean number of rainy days 57. There are, as mentioned earlier, three different rainy periods covering 8 months of the year, following closely one after the other. Of these June to September is the principal rainy season. The annual variation of rainfall shows two maxima and two minima Fig. 1(c). The principal maximum is in September and the secondary maximum in May. These are also the months with the maximum frequency of thunderstorms. Bangalore receives 64 percent of the total rainfall in the southwest monsoon period (June to September), with a rainfall of 449 mm and 32 rainy days. The rainfall increases from June to September with the maximum rainfall occuring during September and October while in the major parts of India, July and August are the rainiest months. The southwest monsoon rains commence in the first week of June and close about the end of September. During the northeast monsoon period, which follows closely on the southwest monsoon, with perhaps a break of a week or ten days, the mean rainfall is 216 mm, which is a quarter of the annual total and the mean number of rainy days is 13. Thus, three quarters of the annual rainfall falls during the 6 months June to November. In April–May, which is a period of summer thundertorms, the mean rainfall is 145 mm and the number of rainy days 9. December to March is a comparatively rainless period, with a mean rainfall of 33.8mm and about 3 rainy days.

The major part of the rainfall and a large percentage of heavy falls, specially during April – June and September – October, is associated with thunderstorms. The intensity of rain is greater in April – May and September – October than in the other months of the year and greatest in September. A major part of the falls of rain of 25 mm and over in a day occurs in these months. During June to August the falls are generally less than 12 mm in a day. The heaviest rainfall that has occured in 24 hours in the 70 years 1881 – 1950 is 163 mm recorded on 27 August 1890. An almost equally heavy fall in 24 hours of 152 mm was recorded on 6 May 1909. The highest total rainfall in a month was 485 mm in September 1897.

Fig. 3 shows the annual rainfall at Bangalore during the 111 years period 1871-1982. The horizontal line corresponds to the normal rainfall of 844mm. Rainfall is generally within 10 percent of the normal in 40 out of the 111 years. It was more than 10 percent in excess of the normal in 42 years and more than 10 percent in deficit in 29 years. The rainiest year was 1874 with a total of 1428mm (1·7 times of the normal) and the driest year was 1876 with a total of 441mm (half of the normal).

Taking the year as a whole, about 85 percent of the rainfall at Bangalore occurs between 4p.m. to 4.a.m. The least rainfall is between 7 a.m. to midday. The maximum rainfall occurs between 6 and 7 p.m. and the minimum rainfall between 10 and 11 a.m. In April, the maximum rainfall occurs between 10 p.m and midnight and and the minimum rainfall generally between 10 a.m. and 2 p.m. During May to August and in October, the maximum rainfall occurs between 9 p.m and 3 a.m.,the maximum being around midnight.

3.5 Winds : The surface winds over Bangalore have a fairly clear-cut seasonal character, with easterly components predominating in one period and westerly components in the other. During the period May to September, the winds are WSW to W, while during the period November to March they are ENE to ESE (Fig. 4.). April and October are transition months when the change-over from the easterly to the westerly winds regime and **vice versa** takes place.

The annual variation of the monthly mean wind speed shows two maxima and minima. The primary maxima is in July, when the westerly winds are prominent, with a mean speed of about 22 Kmph, and the secondary maximum in January, when the easterly winds are prominent, with a mean speed of about 14 Kmph. The two minima occur in the two transition months, April and October, when the mean wind speed is about 11 Kmph. The increase in mean speed is well marked between May and June. The decrease between August and September is also fairly well-marked.

The diurnal variation of wind speed also shows two maxima and minima. The principal maximum occurs generally between midday and 2 p.m. and the principal minimum between 4 and 6 a.m. The subsidiary minimum occurs between 7 and 9 a.m. The strongest winds in the year occur about midday to 2 p.m. in July and the weakest winds between 5 and 7.a.m in March. The diurnal variation in wind direction is not prominent during June to September when the direction is mainly WSW, nor in November to Febuary. The direction is mainly ENE in November, ENE to E in December, E in January and ESE to E in Febuary. In March and April, winds have a slight southerly component in the morning and night after 6 p.m and a northerly component in the morning.

Occasionally squalls associated with thunderstorms and rain occur, principally in April-May and September-October. The highest wind speed recorded so far is 106 kmph, at about 3.20.p.m. in a squall from the NE on 3 May1950. Two other severe squalls occured on 26 May 1947 and 10 May 1948 when the highest wind speed reached was 99 and 102 kmph respectively.

3.6 Weather phenomena : The most important weather phenomena affecting the climate of Bangalore are the thunderstorms and associated squalls and the early morning mist or fog. The curve of thunderstorm distribution during the year shows two maxima corresponding to the maxima and minima of rainfall distribution. The primary thunderstorm maximum occurs in April – May and the secondary

maximum occurs in September – October. The two minima are in July–August and December – February. There are as many as 46 thunderstorms in a year. May experiences the largest number (about 13) with April coming next (about 9). September and October each have about 5.

Thunderstorms occur generally between 4 and 9 p.m., the highest frequency being at about 8 p.m. They are associated with moderate to heavy, though short–lived, rainshowers, sometimes with hail. Some of the thunderstorms are acccmpanied by squalls which may at times be severe. Some thunderstorms in September and October occur late in the night or very early in the morning before 4 a.m.

Early morning mist or fog occurs during October to February but mainly in December–January, There is considerable dew deposition in the late night and early morning hours during November to February. The fog and mist start in the early morning at 4 or 5 a.m. and clear by about 9 or 10 a.m. A thick fog sometimes lifts up and stays as low stratus clour for sometime.

An important feature which influences the climate of Bangalore, and makes it what it is, is the low cloud which covers almost the entire sky during the greater part of the day from June to September. The morning is generally overcast with stratus at a height of 180 to 300 metres, with occassional drizzle or light rain.

4. A study of climatic change at Bangalore from 1875 to 1980.

4.1 The climatological data for Bangalore for three periods - 1881-1940, 1931-1960 and 1977-1980 are given in Tables I, II and III. An examination of the mean temperatures shows that they agree within 0.1°C–0.5°C and there is no long term change between the two periods 1889–1940 and 1939–1960. There is a small overlap of 10 years, but this would not make the comparison invalid. The mean temperatures in Table III for 1977–80, show differences of the order of 0.1 to 1.8°C. This might be partly due to the very short period for which data in Table III were collected. Conventionally climate is represented by the mean value and the variance of a long series (usually 10 to 30 years) of observation of these variables.

The differences between the two sets of values in Table III can also arise from the fact that they were taken at two different sites, situated 5 km apart. A statistical analysis of data for a long period would provide more reliable results and such a study is reported in the next section.

4.2 Among the various factors that constitute the Climate of a place, temperature and rainfall are the most important. An attempt was made by Srivastava *et al* (1977) to examine if any significant changes in these parameters occured at Bangalore during the last century.

The data used for the statistical analysis were the annual mean temperature and annual total rainfall for Bangalore for the 100-year period 1875 to 1976. These are

given in Tables V and VI and shown in Fig. 5. Srivastava *et al* (1977) found the mean value of the temperature to be 23.7°C with a standard deviation of 0.39°C and the coefficient of variability to be only 1.6 percent. The mean value of the rainfall series was found to be 900 mm with a standard deviation of 18.7 mm and the coefficient of variability was about 21 percent. The variability in the temperature series was quite small while in the rainfall series, it is quite considerable.

Any climatic change, characterised by a smooth, monotonic increase or decrease during the period of the record, is termed the climatic trend. The presence or absence of such a trend in the series could be determined by hart's test, which bring out the independence of successive observation by a specially defined ratio. The value of this ratio for the temperature series was found to be not satistically significant, while the ratio for the rainfall series, was satistically significant. They found therefore no evidence of a climatic trend in the temperature series, indicating that Bangalore has not become hotter or colder during the period 1875-1976. On the other hand, there was evidence to show the presence of a secular trend in the rainfall series.

The rainfall series, was therefore subjected to harmonic analysis to detect the nature of the climatic trend. The values of rainfall estimated as a result of analysis are in Fig.5(b) which brings out clearly the nature of the oscillation of the series. The analysis done in 1976 indicated that during the next few years Bangalore would be wetter as the rainfall was likely to increase after 1976. Actual observations shows that this prediction was roughly correct. The actual periodicities will, however, have to be confirmed by means of power spectrum analysis.

It must be pointed that the mean temperature used in this study was the mean of the daily maximum and daily minimum temperature and is not the mean of the hourly values or the mean of less frequent 3 hourly synoptic observations. A study of these values might indicate a trend, particularly if the periods for which higher temperatures persist during a day has increased during the last 100 years.

A study of the mean monthly maximum temperature for the warmest month April during 1893-1982 and of the monthly minimum temperature for the coldest month December was therefore made (Figs.6 & 7). While large variation occur from year to year, there is a steady overall increase in the minimum temperature, with an increase from about 14°C in 1890 to about 16°C in 1977. But the maximum April temperatures which were about 34°C around 1890 and rose to 35°C by 1930, showed a dramatic fall during 1930–1940 to 33°C followed by steady increase to about 34.5°C in 1982, after a sudden fall to 32° in 1977. Whether the changes are real or due to changes in the instruments used has to be ascertained.

5. Comfort Parameters

A further study was made to see if the relative strain which climatological factors bring upon the body's metabolism and heat regulating mechanism had increased during the last few decades.

The important climatic factors which enter into a quantitative estimate of human comfort or discomfort are air temperature, humidity, radiation and wind. The terms of discomfort, defined in the World Meteorological Organization Technical Note on "A Survey of Human Biometeorology", are temperature and humidity values of 20°C and 85%, 25°C and 60%, 30°C and 44% and 35°C and 33%. Experience in air conditioning in many countries has shown that with an air temperature between 16°C and 24°C and a relative humidity between 40 to 70%. one can work indoors with maximum comfort.

A parameter "effective temperature", had been originally used as an arbitrary index, which combines into a single value the effect of temperature, humidity and air movement on the sensation of cold or warmth felt by the human body.

Since this is not a parameter readily arrived at, a "discomfort index" was suggested by Thom (1959). This index D. I. is given by

$$D.I. = 0.72 (T_d + T_w) + 40.6$$

where T_d and T_w are the dry bulb and wet dulb temperatures in degrees Celsius. According to Thom (1959) discomfort will be felt by human beings as the index rises above 70, with over half uncomortable with $D.I > 75$ and everyone uncomfortable with $D.I. > 79$. As the index passes 80, discomfort becomes acute.

Table VII shows the discomfort index, hour by hour, for Bangalore for each of the 12 months. The D.I was computed from data obtained at the Raman Research Institute from 1977 to 1980 by D. Krishna Rao.

It will be seen that while $D.I. > 70$ in all months from 13 to 17 hours, it is greater than 75 during March to May form 11 - 19 hours. The worst months are April and May but even in the other months the afternoons are fairly uncomfortable. The nights are pleasant throughout the year except during March to May (Fig.8.).

A similar diagram prepared by Parathasarthy and Dhar(1972)is shown in Fig.9 for the period 1959-68. There is not a great difference between the two diagrams, nor a marked increase in the discomfort index since 1959 except during the afternoon hours 12-16, from August to October. The conclusion to be drawn is that in the open air, there has been no significant change in air temperature or the discomfort index during the two decades, but for a slight increase in the afternoon from April to may and August to October.

In places like Calcutta and Madras D.I. has values which lie in the range 75-80 throughout the day, from March to November, values less than 70 occuring only from December to February. In Delhi D.I. is above 75 throughout the day from May to September. Values less than 70 are never experienced in Madras. So one can appreciate the advantages of Bangalore over many cities in India.

Siva Rama Krishnaiah (1965) used Lee's (1958) formula for the study of human comfort and determined the degree of comfort for Bangalore based on data from

1930 - 1960. He found Bangalore to be comfortable from March to October and most comfortable in June. Choudhuri and Ganesan (1981) computed the comfort index for about 223 stations in India based on climatological data for 1931–60. They found Bangalore warm most of the year hot during April to June. Since both these studies were based on mean temperatures calculated from the 0830 and 1730 hours observation and not hourly values as in the present study, no great importance need be ascribed to their conclusions.

6. CLIMATIC EFFECTS OF URBANISATION

6.1 General : An examintion of the clmatological data for the last 115 years has shown no appreciable increase in the air temperature and only a marginal increase in the discomfort index. Climatological normals are based on minimum data for at least thirty years, and there will be departures from the normal. We have also seen that the variability is small for temperature, while it is large for rainfall and the trend in the latter also shows a marked periodicity. But there is a general feeling, which is widely shared by both old and new residents of Bangalore, that the climate has changed for the worse in Bangalore. We have just seen that the climate has not; what has probably is that the climate in the built–up areas of Bangalore has changed from a rural to an urban one.

The average changes in climatic elements caused by urbanization are given in in Table VIII(Landsberg, 1970). Contaminants and gases in an urban atmosphere are 5 to 25 times more than in rural environment, rainfall and cloudiness 5 to 10 percent more, fog as much as twice as frequent (in winter), temperature 0.5 to 2.0°C higher, relative humidity about 2 percent less, radiation 15 to 20 percent less and winds 20 to 30 percent less.

6.2. Microclimate: Whenever man changes the landscape, he modifies the microclimate of the area. All man–made features like buildings and roads, ponds and ploughed fields, modify the microclimate of a region. Around every such feature we have what is called a ' climatological sheath ', within which wind, temperature, humidity, rainfall and soil moisture will be different from that outside it. When groups of structures merge into towns and cities we have a climatological dome, within which exists meteorological anomalies. The microclimates of urban parks and the shaded sides of streets remain as special anomolies within the urban climatological dome but on the larger scale of the city, many common features can be detected sometimes upto a height of 1 km.

6.3. Factors affecting the climate in urban areas: The main factors which cause these changes in urban climate are :

(i) Increased surface roughness, which affects the flow patterns, wind field and the turbulence spectrum ;

(ii) Changed albedo ; buildings and roads have different reflecting properties, asphalt surfaces reflect less, while gravel and concrete road surfaces reflect more than their surroundings ;

(iii) accelerated run off ; rapid run off of rainfall caused by the imperviousness of the surfaces of roads, roofs and paved areas reduce evaporation and cooling from built-up areas, and

(iv) changed heat storage capacity ; the greater heat experienced in a city on a sunny afternoon is due to the small heat capacity of the walls and roofs of buildings and the absence of any cooling caused by evaporation from vegetation.

The replacement of forests and fields by concrete and asphalt roads and buildings change the heat balance of the region significantly. We essentially convert the spongy, often moist soil cover of rural areas, of low heat conductivity and appreciable albedo, into an impermeable surface layer with high capacity for conducting heat ; and because of generally lower albedo, high absorptivity for radiation, the heat again is effectively stored in stone asphalt, concrete and the deeper compacted layers of the city. In contrast, vegetated rural areas reflect more incoming radiation and store less in the soil, where plant material may act as an efficient insulator. So the structural features alone favour a positive heat balance for the city. To this we can add local heat production from combustion (energy production of various types) and metabolic processes (human and animal). The end result is the so–called 'urban heat island'.

6.4. Incipient heat islands : Even a single block of buildings can start the process of heat island formation. Fig. 10 shows a series of temperature measurements taken near a two–storeyed concrete building, over a paved yard and over grass, on a cloudy summer afternoon on 19 May 1977 in the Raman Research Institute. It is a typical example of microclimatic heat island formation in incipient urbanisation. The top two curves show temperatures immediately above the paved yard in the front of the building and a few mm from the building wall facing north. The middle curves show air temperature at a height of 1.2 metres over the paved yard and over grass. The lowest curve shows the temperature a few mm above the grass on the lawn. From 4 p.m. onwards, throughout the period observation, the air immediatly over the yard and near the stone wall were 2 to 7°C warmer than the air 1.2m over the paved yard and over the grass. The temperature immediately above the grass remains the lowest throughout. The differences are as high as 8°C between the air immediately above the paved yard and the grass at 4 p.m. falling to 3°C after 6 p.m.

Figure 11 shows similar temperatures for a whole day from 12 noon on 22 May to 23 May 1977. The pavemet and wall temperatures remain uniformly higher throughout the day and night than the air 1.2m over the paved yard and grass. The wall facing west is naturally warmed more rapidly in the afternoon and is warmer

than the paved yard in the afternoon. During the rest of the day and night, the west facing wall cools more rapidly and is then cooler than the paved yard. The grass is warmer than the air 1.2m above it and the air above the paved yard during the day, due to the direct absorption of incoming radiation and cools papidly after 3 p.m. and remains cooler throughout the night. The air 1.2m above the paved yard is uniformly warmer than that 1.2m above the grass throughout the day and night as may be expected.

On clear relatively calm nights, a small heat island develops over the region of the paved yard, fed by heat stored during a sunny day under the paved yard and the stone walls of the nearby building. This slows down the nocturnal radiative cooling process, relative to the radiative cooling from the grass surfaces, keeping the air over the paved area warmer than that over the grass. Similar experiments have shown that the day–time heat transport into the soil under an asphalt pavement on a sunny day may be two and a half times as much as that into a vegetation covered soil.

6.5 Urban heat islands in Bangalore

It is obvious that numerous such heat islands exist in and around built-up areas of the city, particularly near very large buildings surrounded by paved roads unprotected by trees. In order to identify and locate the urban heat islands in Bangalore, a series of measurements of the temperature and humidity of the air was made during April and May 1977. The ideal method is to take simultaneous observations from an extensive network of say 20 or 30 observing stations. Since the existing four observatories are far from the built–up areas and in view of the cost involved, a mobile survey was carried out. The data obtained were supplemented by routine observations made at the four observatories and the Raman Research Institute. Two traverses were made of the city on 28 and 30 April 1977. On the first day, 28 April, a traverse was made from North to South from Hebbal to Banashankari along Bellary, palace and Krishnarajendra Roads. On 30 April, the traverse was from west to east along Station, Seshadri, Richmond and Domlur roads from Rajajinagar to HAL airport. Each traverse took about two hours. Temperature and humidity observations were made, using calibrated paychrometers, by two observers moving in a van during the maximum temperature epoch 12-15 hours IST when two changes in temperature with time will be a minimum. The highest temperatures were, as to be expected, measured in the most crowded build-up areas of Rajajinagar and Domlur and the lowest in the Cubbon and Lalbagh parks, Krishna Rao park and near the ASC Centre (Fig. 12).

Heat island are, however, most prominent noticed around the minimum temperatures epoch, early in the morning, when the time–temperature curve is flat and variation least. So that next three surveys were made in the early morning from 4 a.m. to 7 a.m. on 20, 21 and 27 May 1977. This time a number of selected points in the city were chosen to ensure adequate coverage of the main urban and suburban areas. The survey was started from the Raman Research Institute, where the first

obesrvation of temperature, humidity, wind and cloud was made the time noticed. The whole city was covered in a figure of 8 traverse during the next 3 hours, the observation being repeated carefully at each of the 22 locations. The survey was completed by taking the final observation at the Raman Research Institute and completing the the circuit. These two begining and end readings give the trend in the temperature change. One observer was located at Cubbon Park from 0530–0640 and another at Basavanagudi. The temperature trend obtained by those two observers were used in interpolating the values obtained to make trend correction more accurate and representative. 27 observation in 10 selected areas were made on 20 May, 15 observations in 12 selected areas on 21 May and 38 observations at 28 locations on 27 May.

Figure 13 shows the temperature field over Bangalore City on 27 May. There was clam, or light winds 4 to 6 Kmph, throughout the period of obeservation, with clouds developing from 0530 till the sky was overcase by 0645 a.m. The urban temperature were in excess of those over the suburban areas by about 2°C. The maximum excess was 2.6°C, the hottest part of the city being the built-up areas to north east of Bangalore. Corresponding to the rise in temperature, was a fall in relative humidiy by about 10%. The surveys reported above were carried out 6 years ago. It is obvious that these should be repeated particularly during the cold season, when temperature differences will be more marked.

The character and intensity of the island varies from city and season to season. Topogrphy also causes changes, low lying areas being warmer than the higher ones. Mobile surveys made at Poona in February 1971 gave a temperature excess of 2°C on a windy day and 5 to 6°C on a clam day and in Bombay on a windy day, a temperature excess of 6°C.

6.6. Thermal comfort: Freedom from thermal stress, apart from protection from wind and weather, is an important human need. Thermal comfort may be defined as that condition of the mind which expresses satisfaction with the thermal environment. A basic aim in the design of human settlements should be to promote thermal comfort using minimum necessary inputs of non–meteorological energy. The building designer should attempt to achieve satisfactory thermal comfort over as large a proportion of the year as possible in the given climate and within the resources available. He must be able to assess the causes of thermal stress in different climates and design his buildings better, so as to reduce climatic stress and to provide comfort over a greater period.

The four main physical factors which constitute the external thermal environment are :

(i) Air temperature

(ii) Mean and radiant temperature

(iii) Air velocity relative to the human body radiation and

(iv) Vapour preasure of the ambient air.

In addition both human thermal comfort and stress are influenced by the activity level which determines the internal heat production in the human body, and the themal resistance of the clothing worn. In sedentary activity a human being produces about 58 W/m^2 of body surface area. As activity increases, so the body heat output increases.

A very large number of studies have been carried out on thermal comfort, and particularly on thermal stress in hot climates. The least one should expect from architects and building designers is the use of this vast mass of data in the correct design of buildings for maximum human comfort.

That the use of overglazing of recent buildings in Bangalore, for example, has led to extreme discomfort for their occupants was proved by a series of temperature measurements taken in an old conventional house and in a modern flat in Bangalore about 2 p.m. on a fairly clear day in May. The temperature inside the old house was about 2.5°C cooler than outdoors and 1 to 5°C cooler than in the flat. Much experimental work in recent years elsewhere also confirm the wisdom of old traditional building solutions which relied on relatively small windows. A critical area of study is that of energy exchange between buildings and their external environments. The external temperature of a wall can be as high as 40°C and of a bitumen felt roof as high as 50°C, when the air temperature is as low as 25°C.

In the case of modern high–rise buildings the scale of the structures is so large that they are important climatic modifiers in their own right. For example tall buildings may produce severe overshadowing of quite large areas of ground or bring air down from relatively high levels to street level, setting up adverse conditions for pedestrians.

The weather around any building complex set in a wider urban environment is modified by the wider complex. It is necessary for town planners and architects to study not only urban climatology — the study of the climate of the total statistical assembly of buildings and other artefacts forming the comprehensive urban systems — but building climatology — the climatology of individual buildings in relation to their individual sites and surroundings. Building design must be on the basis of a reliable prediction of the future response of the building to statistically predicted climatological inputs. Since one is dealing with weather events in future, unless one can predict the meteorological response of a building before construction, it will be too late.

6.7. Possible solutions : Urban heat islands expand and intensify as a city grows, and stronger and stronger winds are needed to overcome them. But the effect of urbanisation is to reduce the winds at street level. So natural solutions cannot be expected to cure the disease. With the rapid increase in population, the heat radiation into the atmosphere may rise to half that received from the sun in a few decades. It has been estimated that even doubling energy consumption every 10

years can lead to unbearably high temperatures. A steady state in population and power is inescapable if we are to survive in comfort.

The solution naturally rests with the town planners and city authorities. Human settlements in recent years have tended to be designed without adequate consideration of environmental factors. In poorer communities this situation has produced unnecessary hardship and suffering especially from heat and cold. In richer communities unnecessarily large amounts of energy have to be dissipated to control the indoor environment by artificial heating and cooling. This in turn has added to the overall pollution loads on the environment. Extravagant designs, poorly related to local climatic impacts have been adopted and the buildings are heavily glazed and poorly insulated. The situation has led to an increasing rate of wastage of resources. At the same time insufficient attention has been given to the design of the outdoor spaces around buildings which are important for human welfare. Tall buildings have disturbed the microclimate adversely. Considerations of transport have tended to dominate urban outdoor design, and little effective consideration has been given to the needs of the people. Outdoor space adds to indoor space and if its design is well conceived and environmentally compatible with human needs, such space can help reduce the stress of living in overcrowded small dwellings, which is the lot of the majority of mankind.

REFERENCES

1. Choudhury A., and H. R. Ganesan, 1981 : Geographical distribution of physio-climatic regimes over India. Mausam, Vol. 32, p. 349–356
2. Krishna Rao D., Discomfort Index for Bangalore (unpublished)
3. Krishna Rao P. R. and T. V. Ramchandra Iyer, 1951 : Climate of Bangalore. Souvenir Volume of the Indian Science Congress, p. 116–130
4. Landsberg H. E., 1970 : Climates and Urban planning. Urban Climates. World Meteorological Organisation, pp. 372
5. Lee D.H.K., 1958 : Arid Zone Research, X Clim. Rev. Res. Unesco, p. 102
6. Mani. A., : Urban Climatology (unpublished)
7. Mani A., 1977 : Climatological aspects of Bangalore presented at the symposium "Bangalore Clean and Green"
8. Page J. K., 1976 : Application of building climatology to the problems of housing and building for human settlements. World Meteorological Organization, Geneva, Technical Note No. 150
9. Parthasarathy B., and O.N.Dhar, 1973 : A Study of human comfort at a few stations in India, National Geogaphical Journal of India, pp 216-222

10. Sivaramakrishnaiah K., 1966 : A study of human comfort of some places in India, Ind. Journ. Met. Geophys Vol. 17 ; p 89-94

11. Srivastava G. P., P. S. Nayar, S. Hariharan and C. G. Joshi : A Study of the climate of Bangalore from 1875 to 1975 (unpublished)

12. Thom E. C., 1959 : The Discomfort Index, Weatherwise, Vol. 12, pp.57–60

13. World Meteorological Organization. WMO Technical Note No. 65 : A Survey on human biometeorology. Ed. by F. Sargent and S. W. Tromp. 1964

TABLE–I

Climatological Data of Bangalore

(Based on 60 years data 1881–1940 at the Central Observatory, Bangalore)

Month	Mean daily Max.°C	Mean daily Min.°C	Mean temp. °C	Mean monthly highest temp. °C	Mean monthly lowest temp. °C	Highest ever recorded temp. °C	Lowest ever recorded temp. °C	Mean monthly diurnal rang temp. °C	Mean wet bulb temp. °C	Mean rel. humidity %	Mean No. of hrs. of sunshine per day	Mean wind speed kmph.	Mean wind direction	Mean monthly total rainfall (mm)
JAN	26.8	14.1	20.4	30.1	11.4	32.2	7.8	12.7	16.1	63	8.5	14.4	N 87°E	6.1
FEB	29.8	15.5	22.7	32.6	12.8	34.4	9.4	14.3	16.7	54	9.4	13.3	S 83°E	6.7
MAR	32.4	18.1	25.2	35.2	14.7	37.2	11.1	14.3	17.8	46	9.5	12.5	S 76°E	10
APR	33.5	20.6	27.1	36.2	18.2	38.3	14.4	13.0	20.5	53	9.0	11.4	S 52°E	40
MAY	32.9	20.5	26.7	36.2	18.1	38.9	16.7	12.4	21.7	60	8.5	13.9	S 74°W	105
JUN	29.1	19.3	24.2	33.1	18.1	37.8	16.7	9.8	21.1	70	5.6	21.3	S 65°W	60
JUL	27.4	18.7	23.1	30.9	17.8	33.3	16.1	8.7	20.5	75	3.8	21.8	S 67°W	96
AUG	27.4	18.7	23.1	30.4	17.5	33.3	14.4	8.7	20.5	76	4.5	10.2	S 72°W	125
SEP	27.8	18.5	23.2	30.7	17.1	32.8	15.0	9.3	20.5	76	5.3	13.9	S 77°W	168
OCT	27.6	18.3	22.9	30.3	16.1	32.2	13.3	9.3	20.0	75	6.0	10.7	N 68°E	148
NOV	26.3	16.5	21.4	29.1	13.2	31.1	10.5	9.8	18.3	73	6.1	12.0	N 66°E	68
DEC	25.7	14.5	20.1	28.3	11.7	31.1	8.9	11.2	16.7	69	7.5	13.8	N 76°E	11

TABLE–II

Climatological Data of Bangalore

(Based on 30 year's data from 1931–60 at the Control Observatory, Bangalore)

Month	Mean daily Max. °C	Mean daily Min. °C	Mean temp. °C	Mean monthly highest temp. °C	Mean monthly lowest temp. °C	Highest ever recorded temp. °C	Lowest over recorded temp. °C	Mean monthly diurnal range temp. °C	Mean rel. humidity %	Mean No. of hrs. of sunshine (1948–75)	Mean wind speed kmph	Mean monthly total rainfall (mm)
JAN	26.9	15.0	20.9	29.6	12.3	32.2	7.8	11.9	59	8.5	10.4	3.3
FEB	29.7	16.5	23.1	32.2	13.7	34.4	9.4	13.2	48	9.1	9.7	10.2
MAR	32.3	19.0	25.7	34.7	15.4	37.2	11.1	13.3	43	9.0	9.4	6.1
APR	33.4	21.2	27.3	35.3	18.5	38.3	14.4	12.2	62	8.7	9.0	45.7
MAY	32.7	21.1	26.9	35.9	18.3	38.9	16.7	11.6	60	7.6	11.3	116.5
JUN	28.9	19.7	24.3	32.5	18.3	37.8	16.7	9.2	72	5.0	17.1	80.1
JULY	27.2	19.2	23.2	30.2	18.1	33.3	16.1	8.0	73	3.3	17.5	116.6
AUG	27.3	19.2	23.3	29.8	18.0	33.3	14.4	8.1	76	4.2	15.2	147.1
SEP	27.6	18.9	23.3	30.3	17.4	33.3	15.0	8.7	73	5.0	12.1	142.7
OCT	27.5	18.9	23.2	30.0	16.7	32.2	13.3	8.6	73	5.7	8.2	184.9
NOV	26.3	17.2	21.5	28.6	13.7	31.1	10.6	9.1	69	6.9	8.5	54.3
DEC	25.7	15.3	20.5	28.1	12.2	31.1	8.9	10.4	65	7.4	9.6	16.2
YEAR	29.8	18.4	23.6	36.2	11.7	—	—	10.4	63	6.7	11.5	923.7

TABLE–III

Climatological Data of Bangalore

(Based on 3 years' data from 1977–80 at the Raman Research Institute and Central Observatory, Bangalore)

Month	Mean daily Max. °C	Mean daily Min. °C	Mean temp. °C	Mean monthly highest temp. °C	Mean monthly lowest temp. °C	Highest recorded temp. °C	Lowest recorded temp. °C	Mean monthly diurnal range temp. °C	Mean rel. humidity %	Mean No. of hrs. of sunshine	Mean monthly total rain. fall (mm)
JAN	(27.5)	(14.8)	(21.1)	(29.7)	(11.8)	(31.3)	(10.3)	(12.7)	(65)	(10.2)	(0.0)
	27.6	15.1	21.3	30.2	12.7	30.9	11.4	12.5	59	9.0	0.0
FEB	(29.4)	(17.6)	(23.5)	(31.9)	(14.9)	(33.4)	(13.6)	(11.8)	(64)	(9.2)	(18.1)
	29.6	17.4	23.5	32.1	14.6	33.2	12.6	12.2	61	8.4	20.5
MAR	(32.3)	(19.6)	(25.9)	(34.7)	(15.5)	(34.0)	(15.4)	(12.7)	(51)	(9.9)	(6.5)
	32.4	19.5	25.9	34.8	15.6	35.0	15.4	12.9	48	8.8	13.4
APR	(33.9)	(21.9)	(27.9)	(35.7)	(19.1)	(35.7)	(18.2)	(12.0)	(53)	(9.2)	(39.9)
	34.1	21.9	28.0	36.4	19.2	36.5	18.5	12.2	53	8.7	42.3
MAY	(32.3)	(21.5)	(26.9)	(35.3)	(19.5)	(35.5)	(19.3)	(10.8)	(64)	(7.9)	(71.5)
	33.0	21.3	27.1	35.0	19.0	36.5	18.4	11.7	63	7.4	117.5
JUN	(28.5)	(20.2)	(24.3)	(32.2)	(19.1)	(33.1)	(19.0)	(8.3)	(78)	(4.8)	(108.9)
	28.3	20.4	24.3	32.6	18.7	34.0	18.1	7.9	75	4.4	101.1
JUL	(25.9)	(19.8)	(22.9)	(30.6)	(18.7)	(33.0)	(18.4)	(6.1)	(81)	(3.3)	(129.8)
	27.5	19.7	23.6	30.2	18.7	31.0	18.3	7.8	78	2.9	98.9

AUG	(26.8)	(19.8)	(23.3)	(28.9)	(18.7)	(30.0)	(18.2)	(7.0)	(80)	(4.3)	(102.4)
	27.4	19.5	23.5	29.4	18.5	30.7	17.8	7.9	78	3.4	94.5
SEP	(27.4)	(19.7)	(23.5)	(29.5)	(17.9)	(29.5)	(17.4)	(7.7)	(81)	(4.4)	(216.2)
	27.0	19.6	23.3	30.4	18.1	30.9	17.5	7.4	78	4.2	245.0
OCT	(27.5)	(19.2)	(23.3)	(29.6)	(16.3)	(29.8)	(16.3)	(8.3)	(80)	(7.1)	(171.7)
	28.1	19.3	23.7	29.8	15.8	29.9	16.4	8.8	74	6.2	139.8
NOV	(26.1)	(18.4)	(22.3)	(28.7)	(15.5)	(29.0)	(13.5)	(7.7)	(82)	(5.6)	(92.5)
	26.8	18.3	22.5	29.2	15.6	29.6	14.5	8.5	78	5.5	74.9
DEC	(25.9)	(16.4)	(21.1)	(27.9)	(13.0)	(28.1)	(11.8)	(9.5)	(76)	(6.3)	(8.3)
	26.5	17.2	21.9	27.9	13.8	28.5	13.2	9.3	70	6.3	7.2
YEAR	(28.6)	(19.1)	(23.8)	(31.2)	(16.7)	—	—	(9.5)	(71)	(6.9)	(80.5)
	29.0	19.1	24.1	31.5	16.6	—	—	9.9	68	6.3	79.6

Note : Data from Raman Research Institute Written in brakets.

TABLE–IV

Rainfall of Bangalore in cm

(Based on seventy years' data from 1881–1950 at the Central Observatory, Bangalore)

Month	Mean monthly total	Mean No. of rainy days	Highest rainfall in 24 hrs.	Date of occurrence	Highest total rainfall	Year of occurrence	Lowest total rainfall	Year of occurrence
JAN	0.61	0.5	6.6	16.1.1908	10.2	1908	—	—
FEB	0.67	0.4	6.6	22.2.1901	9.1	1932	—	—
MAR	1.0	0.8	5.1	10.3.1911	5.7	1905	—	—
APR	4.0	2.6	9.2	15.4.1939	16.7	1929	0.1	1913
MAY	10.5	6.6	15.2	6.5.1909	24.2	1904	0.1	1891
JUN	6.0	5.9	10.0	16.6.1891	9.3	1891	1.0	1909
JUL	9.6	8.0	10.0	23.7.1910	28.6	1916	0.6	1881
AUG	12.5	9.3	16.3	27.8.1890	34.5	1935	2.1	1885
SEP	16.8	8.9	12.5	29.9.1912	48.5	1897	0.9	1934
OCT	14.8	8.5	11.7	19.10.1935	40.3	1928	1.0	1927
NOV	6.8	4.5	11.5	9.11.1916	25.3	1916	—	—
DEC	1.1	1.2	4.7	17.12.1933	5.9	1933	—	—
YEAR	84.4	57.2	—	—	134.6	1916	53.6	1943

TABLE–V

Annual Mean Temperature At Bangalore

(Temperature in °C)

Year	Temp.	Year	Temp.	Year	Temp.	Year	Temp.
1875	23.5	1901	23.9	1927	24.5	1953	23.7
76	23.9	02	23.8	28	23.3	54	23.5
77	24.4	03	23.7	29	24.2	55	23.4
78	23.7	04	23·2	30	24.1	56	23.3
79	23.1	05	23.9	31	24.5	57	23.7
80	23.6	06	24.1	32	23.9	58	23.9
81	23.6	07	23.5	33	23.7	59	23.9
82	22.7	08	23.7	34	23.9	60	23.9
83	22.6	09	23.8	35	24.1	61	23.4
84	22.9	10	23.5	36	24.1	62	23.6
85	23.7	11	23.6	37	23.9	63	23.7
86	23.2	12	23.8	38	24.0	64	23.9
87	23.0	13	23.9	39	23.6	65	24.0
88	23.3	14	24.1	40	23.7	66	24.2
89	23.5	15	24.2	41	24.4	67	23.3
90	23.2	16	23.6	42	24.3	68	23.9
91	23.9	17	23.3	43	23.6	69	23.7
92	23.4	18	23.6	44	23.9	70	23.4
93	23.1	19	24.1	45	24.2	71	23.1
94	23.5	20	23.9	46	23.9	72	23.5
95	23.3	21	23.7	47	24.0	73	23.7
96	23.9	22	23.7	48	24.2	74	23.2
97	24.3	23	23.8	49	23.6	75	23.6
98	23.7	24	24.2	50	23.9	76	23.5
99	23.4	25	23.9	51	23.7	77	23.9
1900	24.4	1926	24.6	1952	23.8	78	23.9
						79	24.4
						80	24.3
						81	24.1
						82	24.1

TABLE–VI

Annual Rainfall (mm)

Year	mm	Year	mm	Year	mm	Year	mm
1875	563.9	1901	939.8	1927	603.0	1953	1202.2
76	410·7	02	828.5	28	973.3	54	873-3
77	961.9	03	1301.7	29	789.7	55	795.8
78	1036.6	04	794.8	30	991.4	56	1121.4
79	1033.0	05	890.5	31	641.1	57	762.3
80	1313.2	06	1012.2	32	1090.4	58	1282.0
81	697.0	07	802.1	33	1049.0	59	969.6
82	940.6	08	655.3	34	628·4	60	890.6
83	883.9	09	1006.3	35	1101.9	61	881.4
84	587.0	10	1170.4	36	771.4	62	1052.7
85	1009.7	11	791.7	37	830.1	63	1036.8
86	1137.7	12	1095.0	38	799.8	64	1191.6
87	863.3	13	544.3	39	895.6	65	692.0
88	748.8	14	735.1	40	929.6	66	1206.0
89	932.9	15	956.1	41	861.8	67	760.4
90	1119.6	16	1348.5	42	829.6	68	868.6
91	620.8	17	900.2	43	1240.8	69	1197.9
92	679.5	18	805·2	44	1009.9	70	1024.3
93	983.0	19	1038.9	45	587.8	71	921.7
94	818.1	20	660.4	46	1042.2	72	894.5
95	914.1	21	930.1	47	910.6	73	888.9
96	721.6	22	872.2	48	1001.8	74	954.5
97	1082.2	23	678.9	49	1070.4	75	1059.0
98	800.9	24	686.8	50	802.6	76	770.0
99	645.7	25	742.7	51	904.5	77	1003.8
1900	798.1	1926	792.5	1952	812.0	78	803.9
						79	1231.6
						80	781.4
						81	855.7
						82	760.4

TABLE–VII

Discomfort Index

Bangalore Mean daily values

DT=0.72 (T_d+T_w)+40.6 (Temperature in °C)

Month	Hours (I.S.T.) ending at 1	2	3	4	5	6	7	8	9	10	11	12
JAN	64	64	64	63	63	62	63	63	66	68	70	70
FEB	67	67	67	66	66	66	66	66	69	70	71	73
MAR	70	70	69	69	68	67	67	69	71	73	75	76
APR	72	71	70	71	69	70	71	72	74	75	77	78
MAY	72	72	72	71	71	71	71	72	74	76	77	78
JUN	70	70	70	69	70	70	70	71	72	73	74	75
JUL	70	69	69	69	69	69	69	70	71	72	73	74
AUG	69	69	69	69	69	69	67	70	71	72	73	74
SEP	70	70	69	69	69	69	69	70	71	73	74	74
OCT	69	69	69	69	68	68	68	69	71	73	74	74
NOV	68	68	68	67	67	67	67	68	70	71	72	74
DEC	66	65	65	65	64	64	64	65	67	69	70	71

Month	Hours (I.S.T) ending at 13	14	15	16	17	18	19	20	21	22	23	24
JAN	72	73	73	73	72	69	68	69	67	66	66	65
FEB	74	75	75	75	74	73	72	71	70	69	69	68
MAR	77	79	78	78	77	75	74	72	72	71	71	70
APR	79	80	79	79	79	77	76	75	74	74	73	72
MAY	79	79	79	79	78	77	76	75	74	74	73	73
JUN	76	76	76	76	75	74	73	73	71	71	71	70
JUL	74	75	75	74	74	73	72	72	71	71	70	70
AUG	74	75	74	75	74	73	72	71	71	71	70	70
SEP	75	75	75	75	74	74	73	72	71	71	71	70
OCT	74	75	75	75	74	73	72	71	71	70	70	69
NOV	73	74	74	72	72	71	70	70	69	69	69	69
DEC	74	72	72	72	71	69	68	67	67	67	66	66

Based on Data from 1977-80

TABLE–VIII

Climatic Changes Produced by Cities

(after landsberg, 1970)

Element	Comparison with rural environs
Temperature	
Annual mean	0.5 to 1.0°C higher
Winter minima	1.0 to 2.0°C higher
Relative humidity	
Annual mean	6 % lower
Winter	2 % lower
Summer	8 % lower
Dust particles	10 times more
Cloudiness	
Clouds	5 to 10 % more
Fog, winter	100 % more
Fog, summer	30 %
Radiation	
Total on horizontal surface	15 to 20 % less
Ultraviolet, winter	30 % less
Ultraviolet, snmmer	5 % less
Wind speed	
Annual mean	20 to 30 % lower
Extreme guests	10 to 20 % lower
Calms	5 to 20 % more
Precipitation	
Amounts	5 to 10 % more
Days with <0.2 inch	10 % more

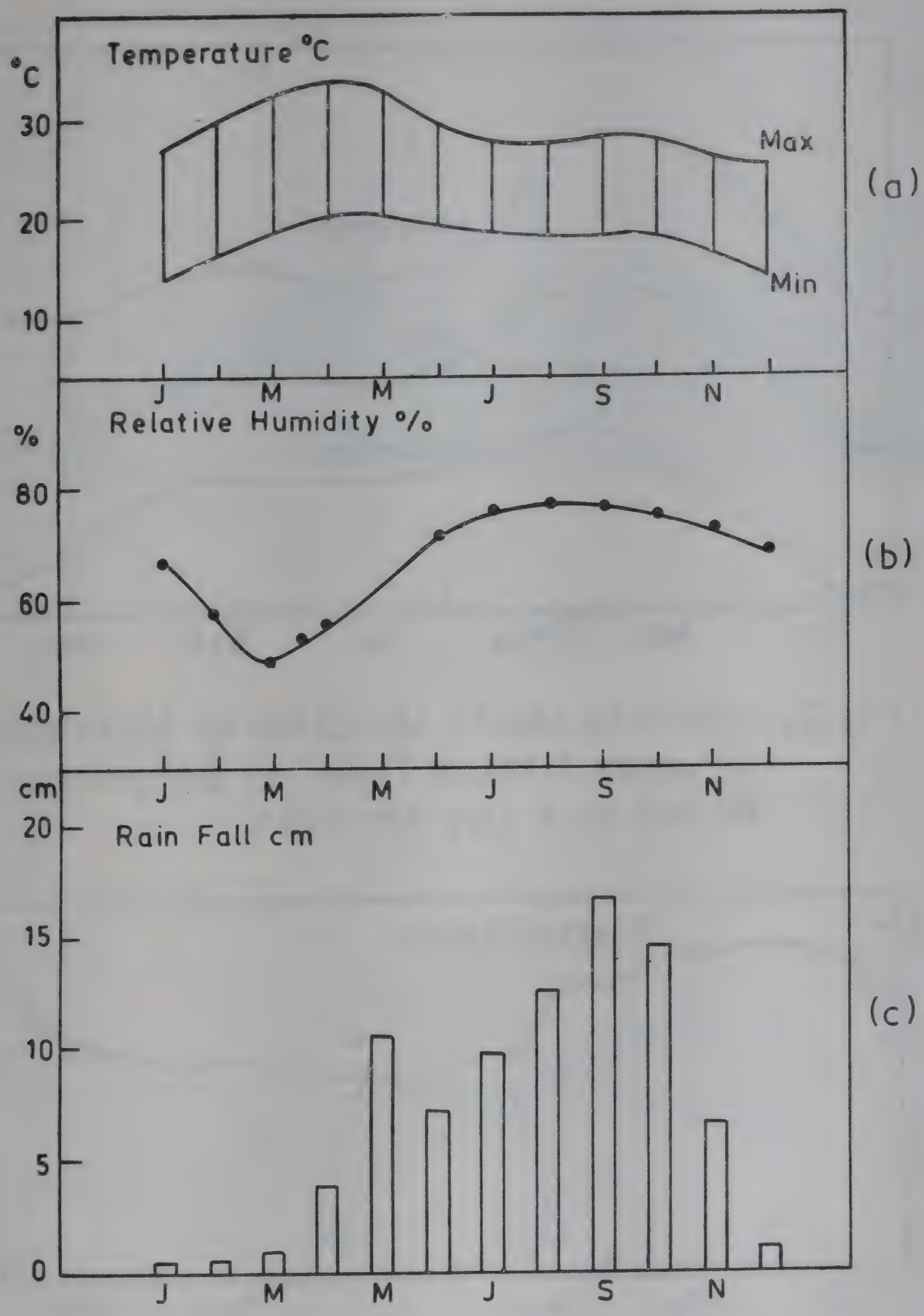

Fig. 1-Month to Month Distribution of Temperature Relative Humidity and Rainfall at Bangalore Based on 60 Years Data. 1880-1940

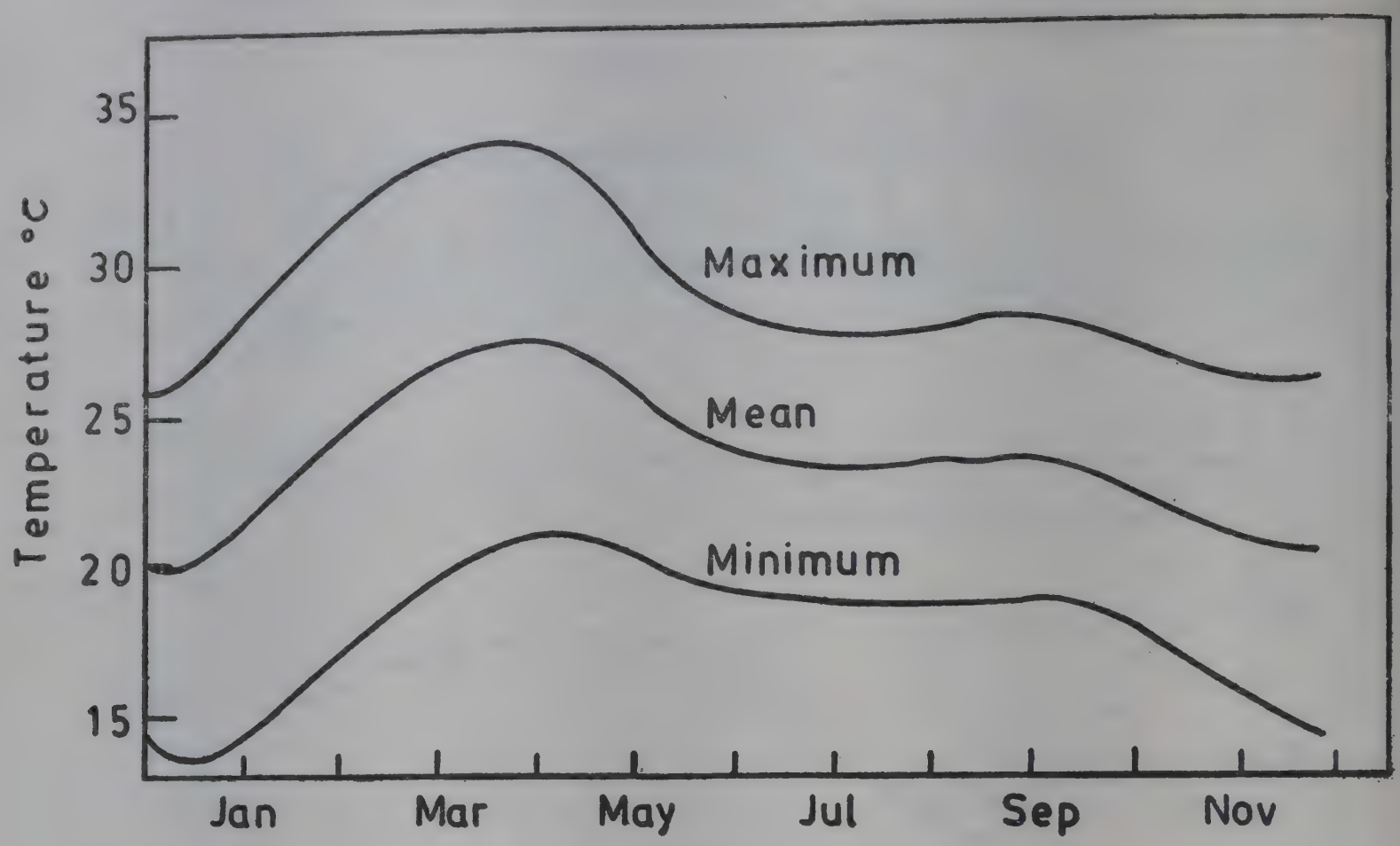

Fig. 2a - Month to Month Variation of Maximum, Minimum & Mean Temp. at Bangalore Based on 5 Day Normals

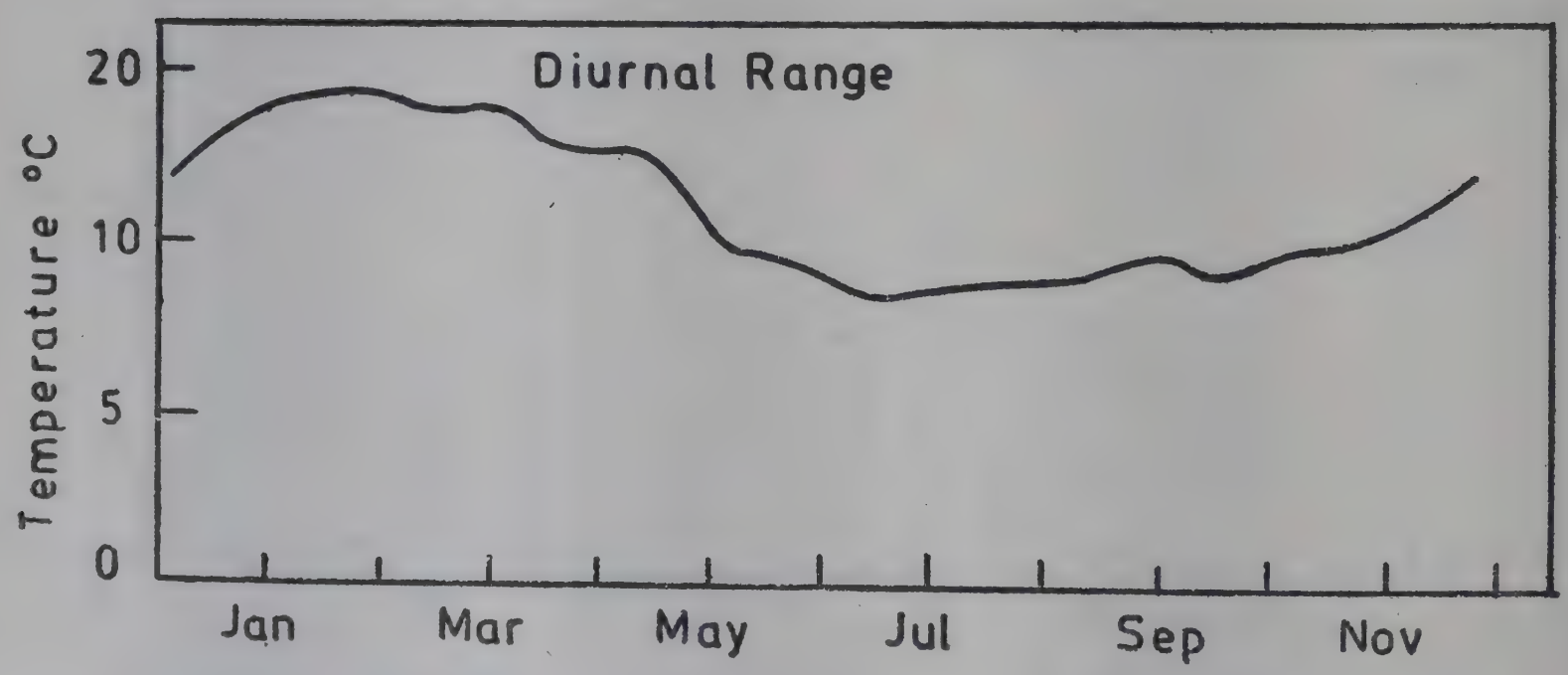

Fig. 2b - Temperature of Bangalore

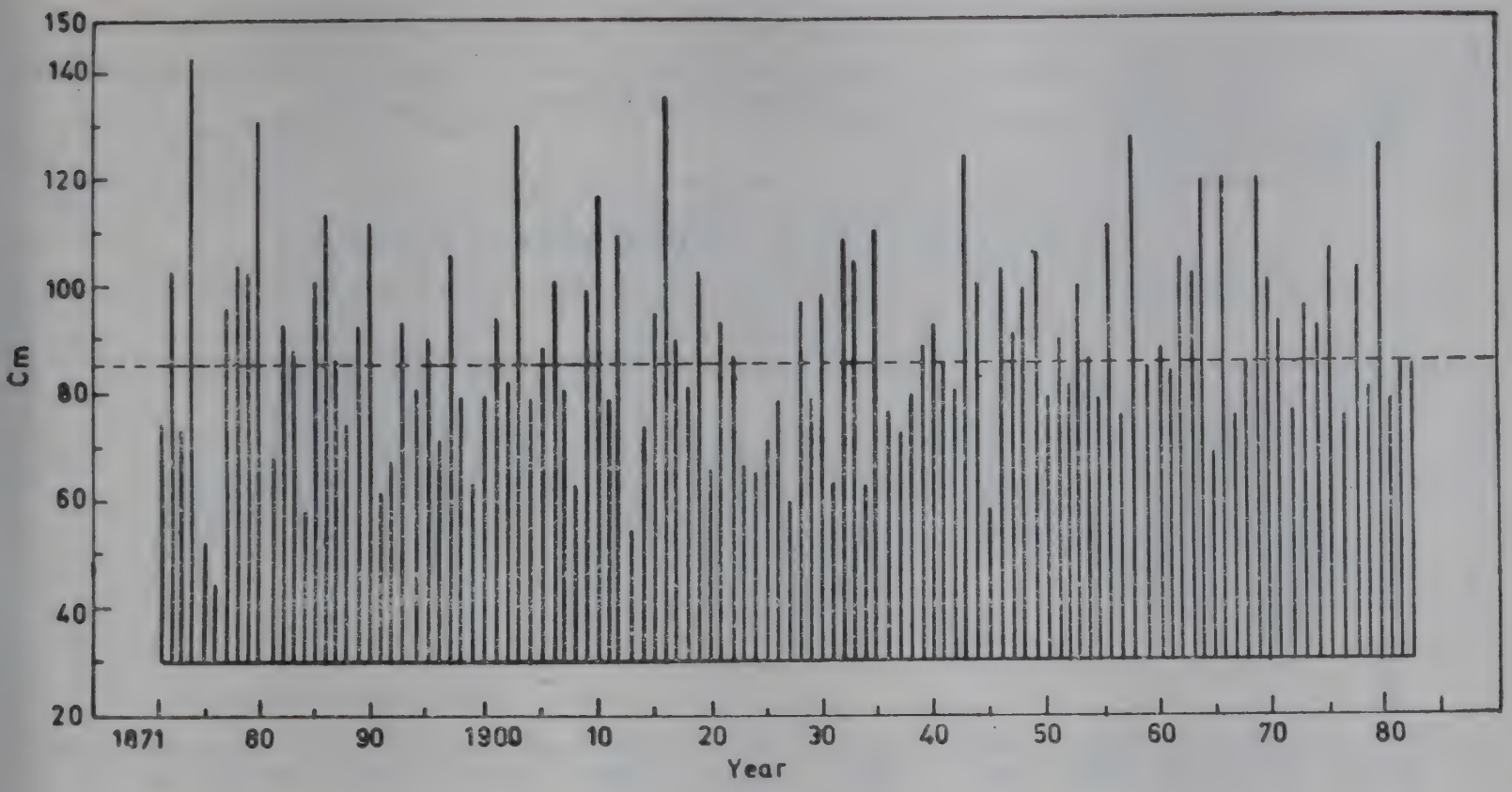

Fig. 3 - Rainfall of Bangalore. 1871-1982

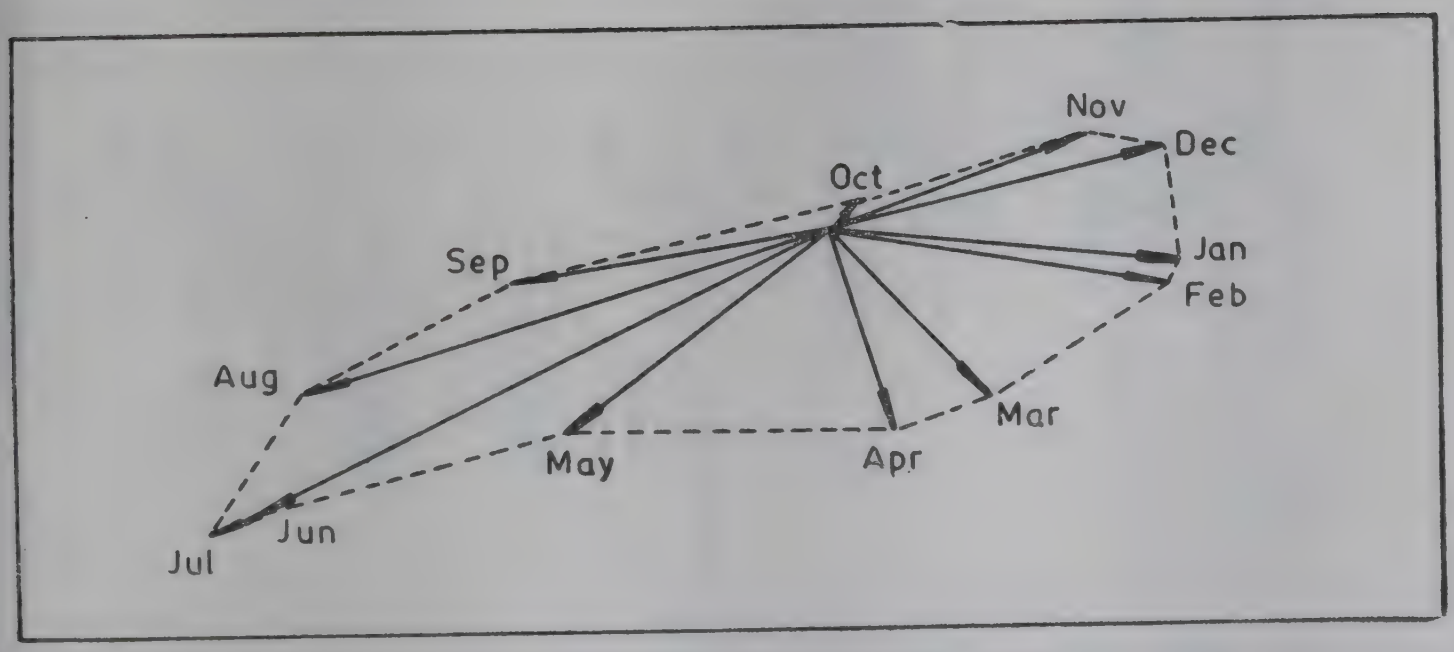

Fig. 4 - Hodograph Showing Monthly Resultant Winds at Bangalore

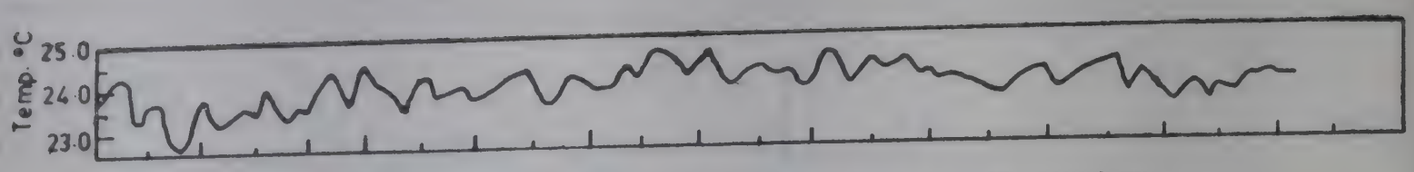

Fig.5a - Annual Mean Temperature at Bangalore

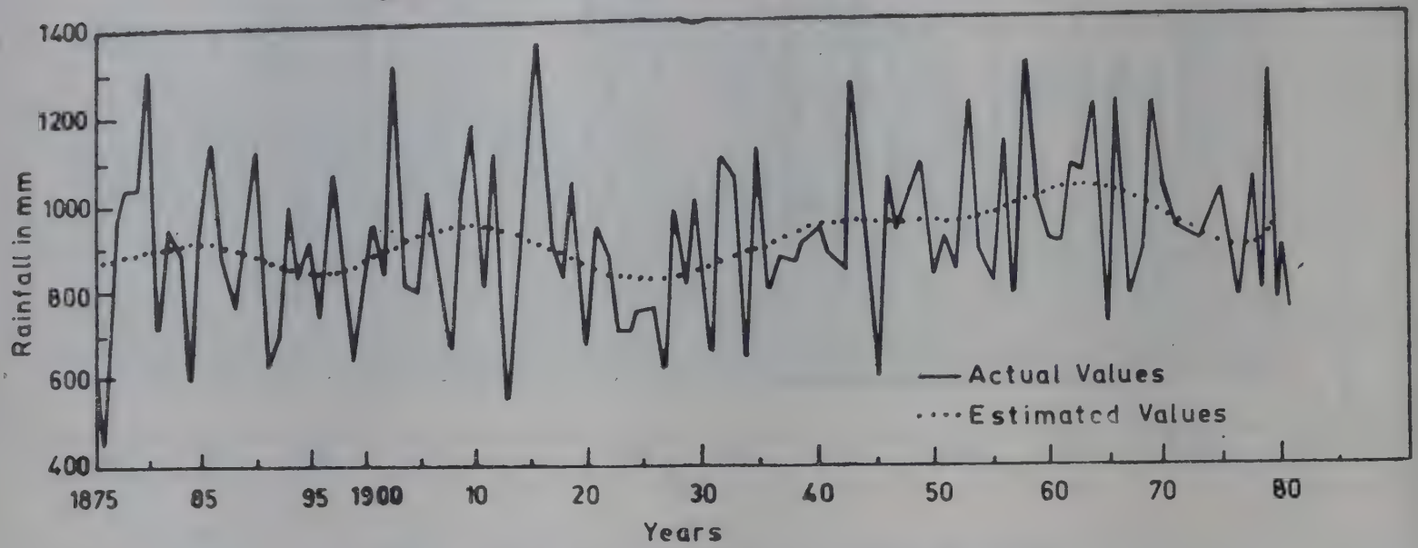

Fig.5b - Annual Rainfall at Bangalore. 1875 - 1982

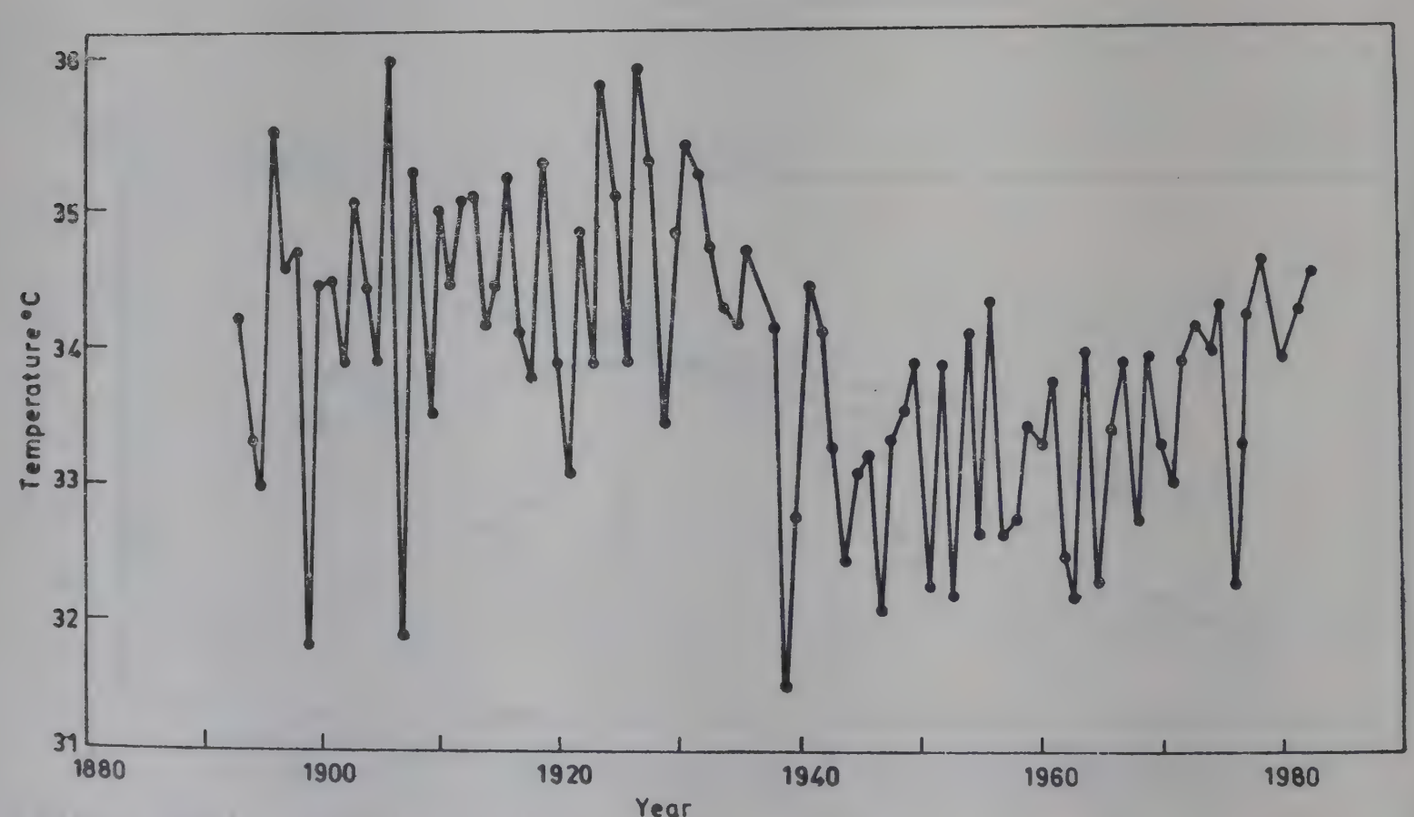

Fig.6 - Monthly mean maximum temperature in April at Bangalore. 1893 - 1982

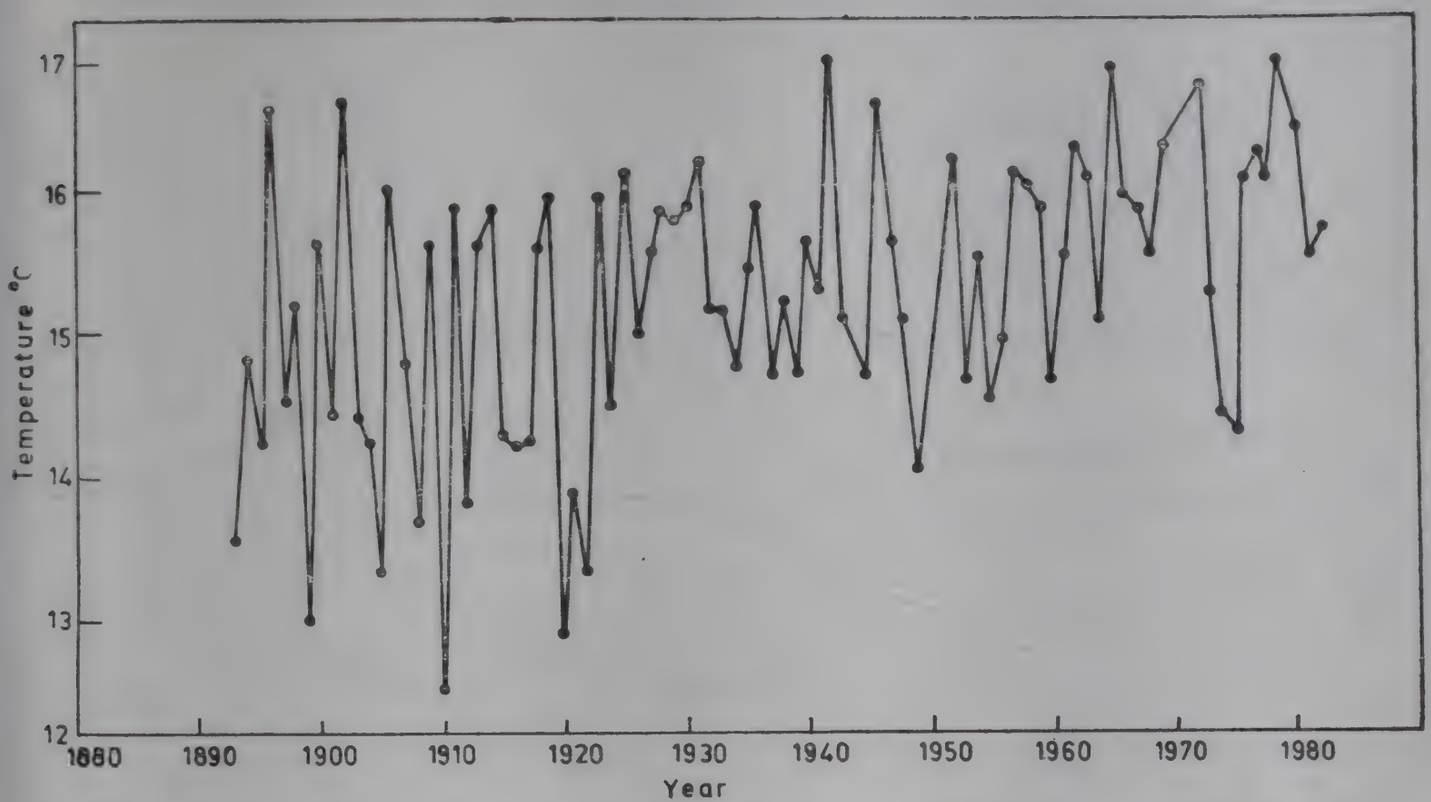

Fig.7-Monthly Mean Minimum Temperature for December at Bangalore 1893-1982

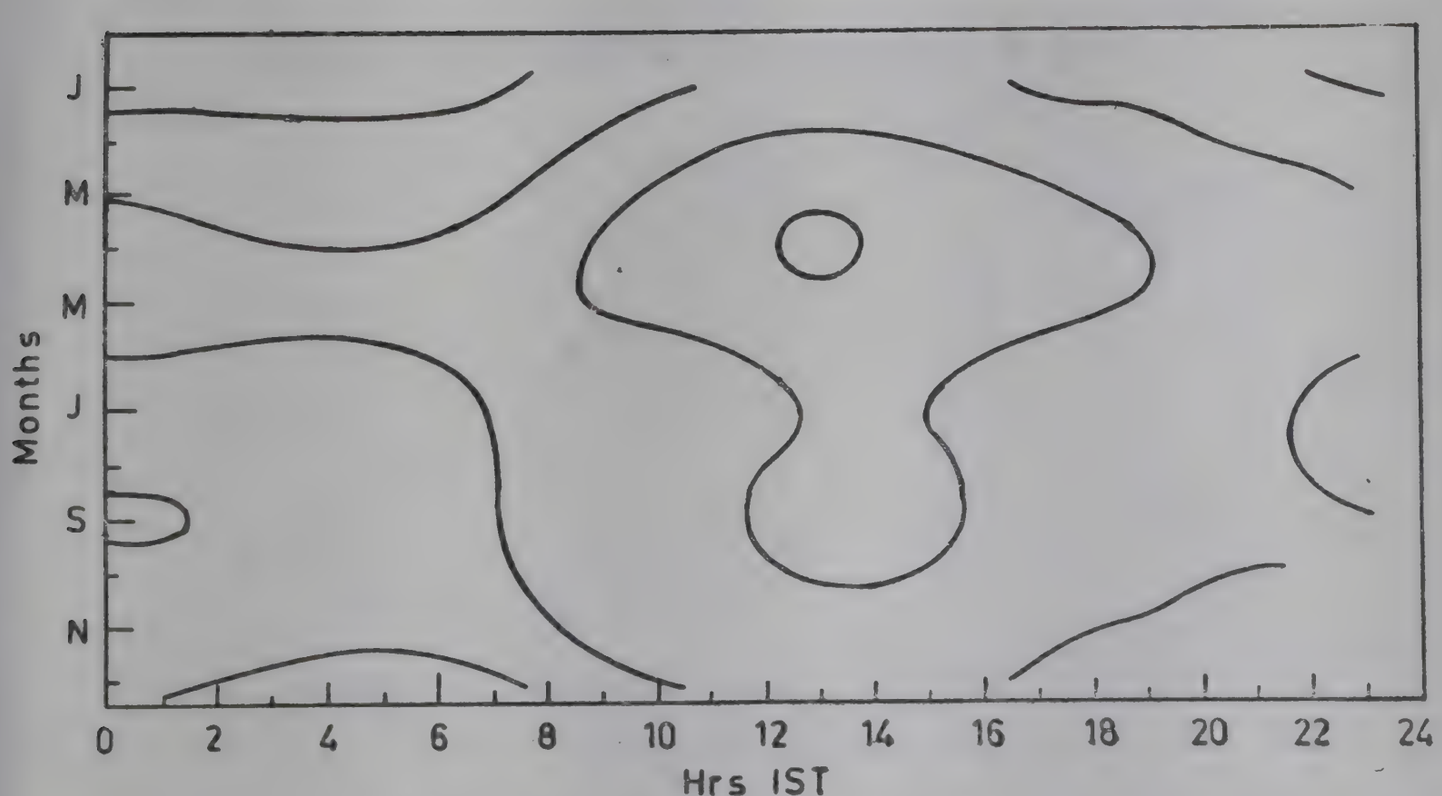

Fig.8-Discomfort Index. 1977-80

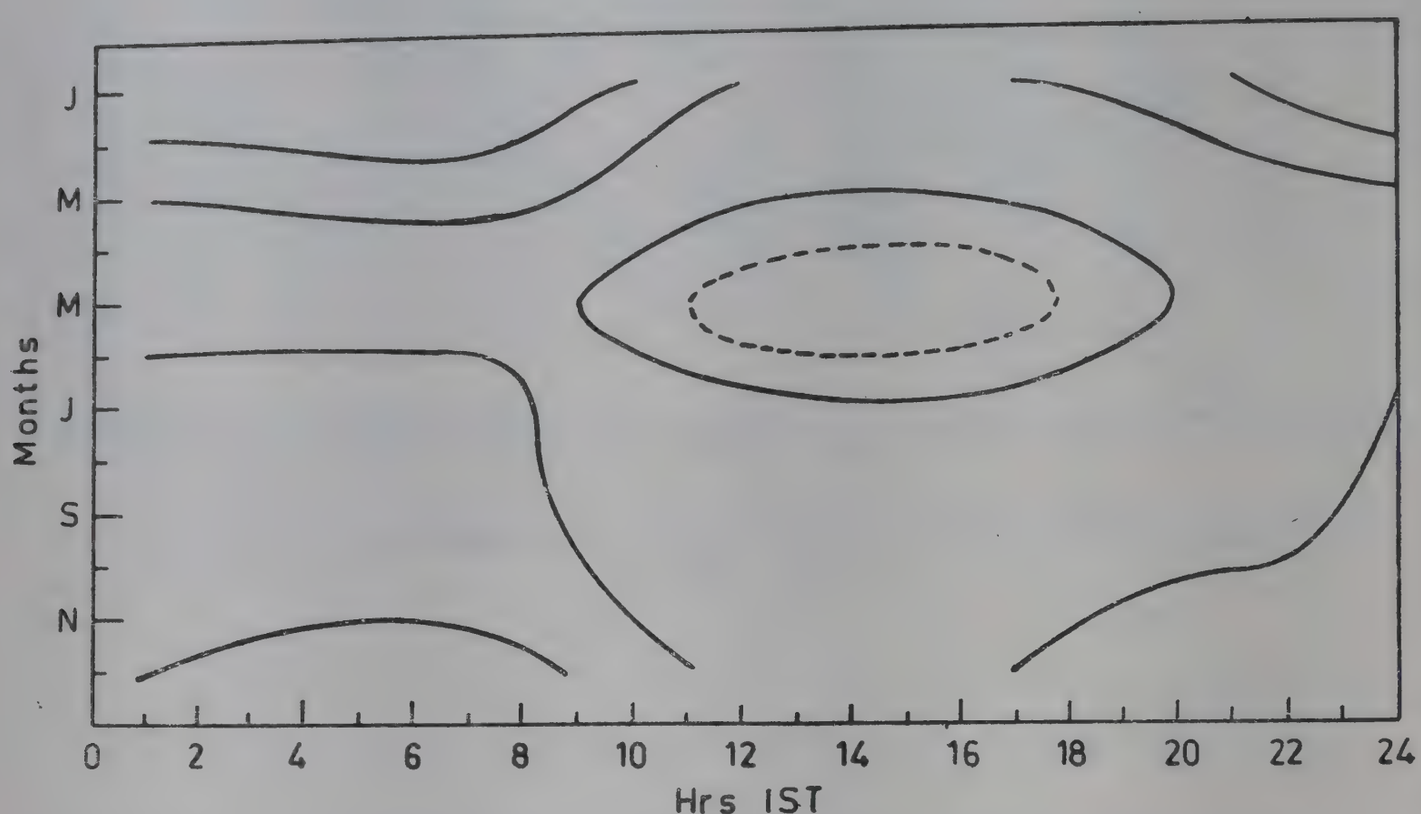

Fig.9-Discomfort Index 1959-1969

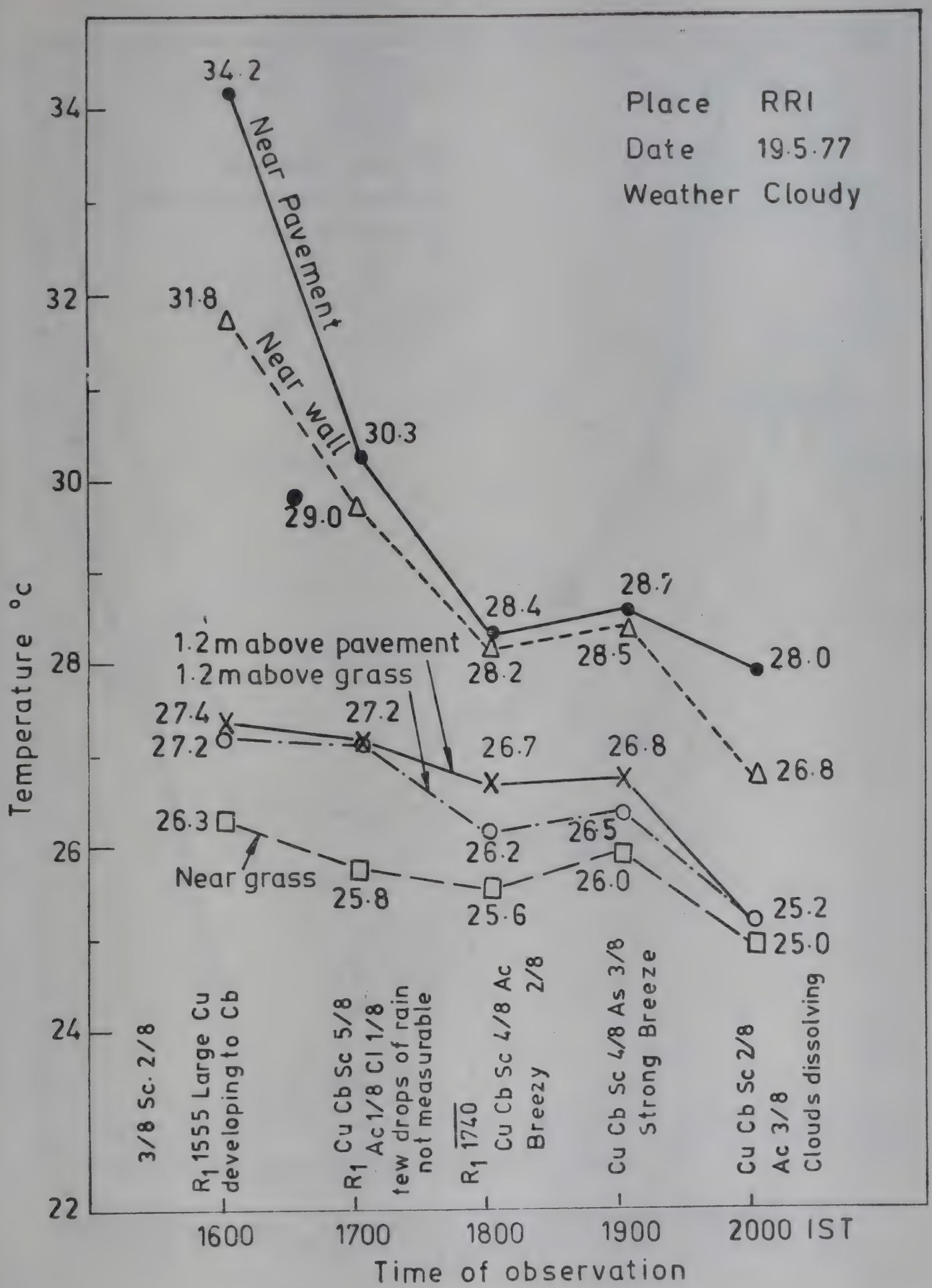

Fig. 10 - Formation of heat island near a building

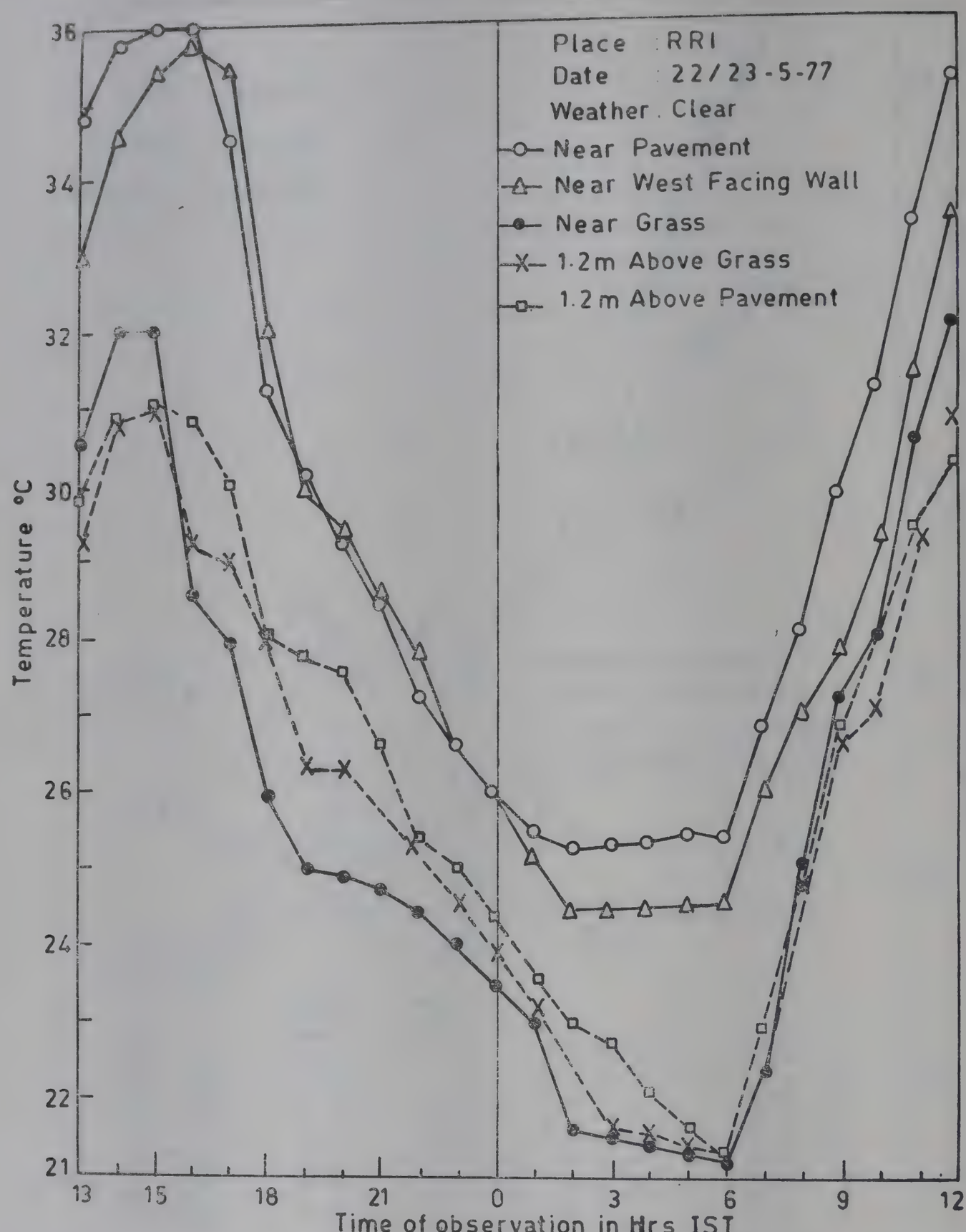

Fig.11-Diurnal Variation of Temperatur near a Building 23-5-77

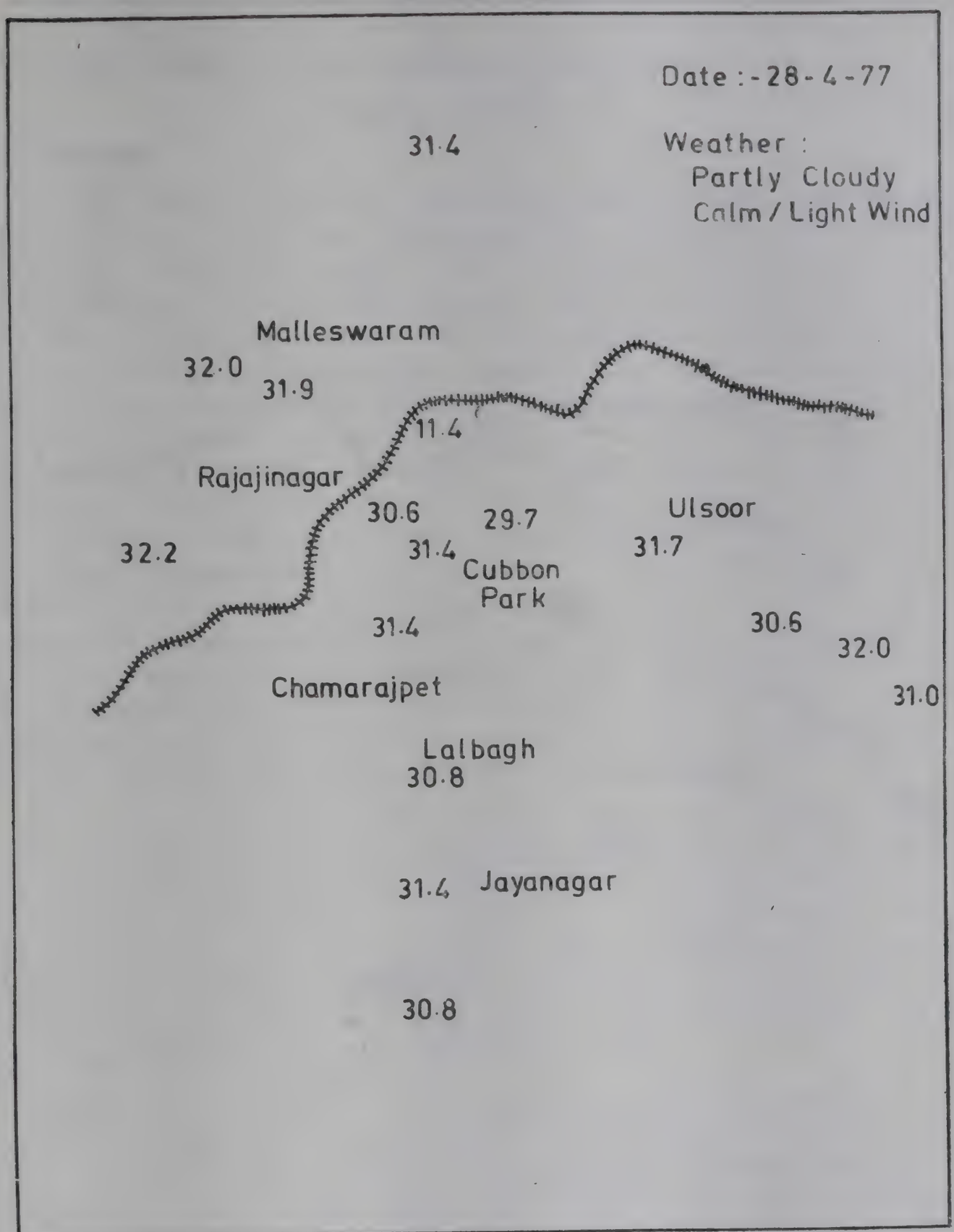

Fig. 12 - Temperature Field Over Bangalore

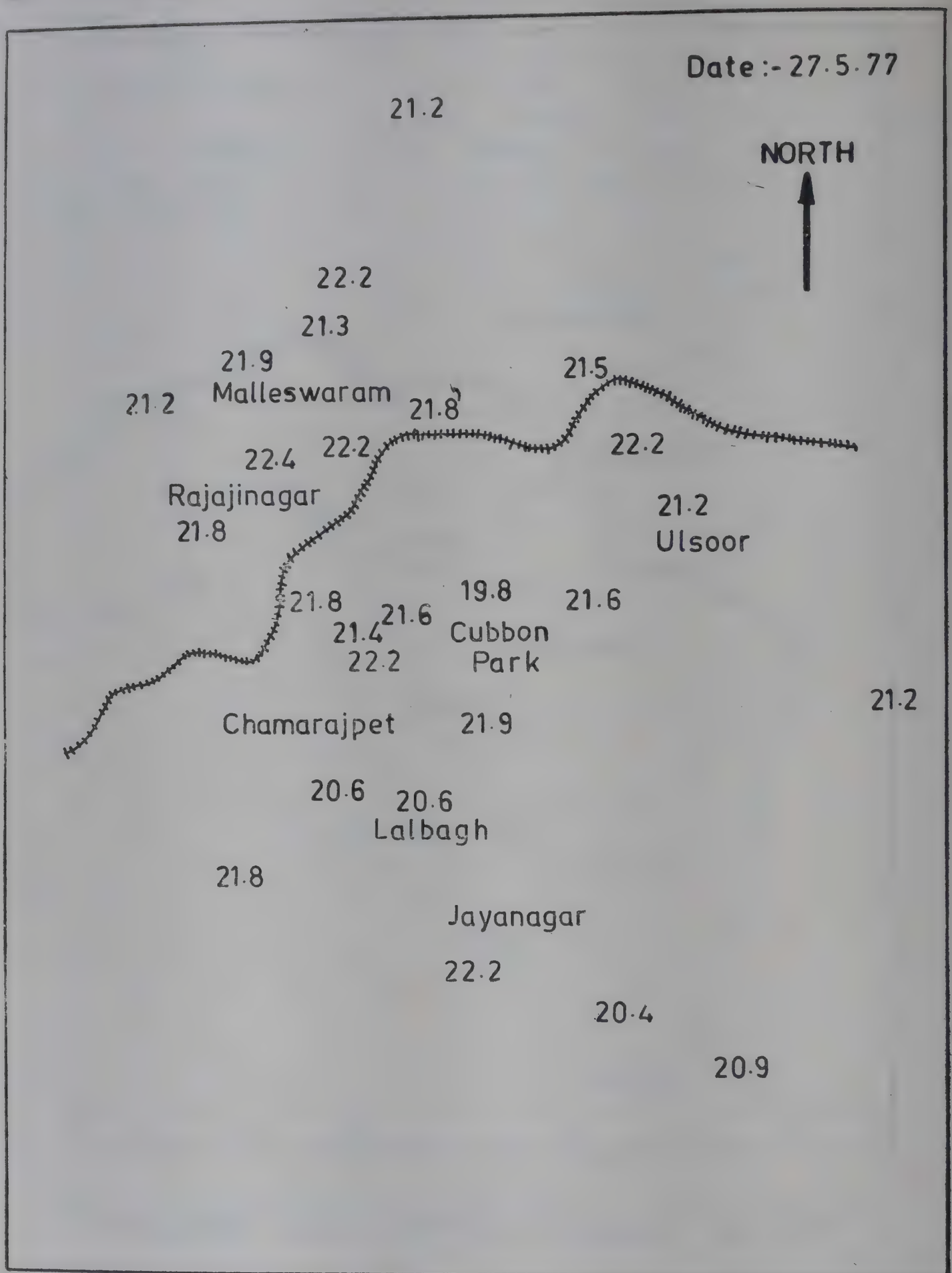

Fig. 13 - Temperature Field Over Bangalore

SLUMMING OF METROPOLIS

H. RAMACHANDRAN *

There are empirical evidences to believe that slum population in metropolitan areas are growing at faster rates than metropolitan populations in general (Ward, 1976; TCPO, 1973). Till recently the administrative response to slum growth was one of indifference (Blomkvist, 1982; Sampath, 1983). Currently, the response of governments is sometimes negative (slum clearance) and at others positive (slum improvement schemes). While growth of slums is considered an undesirable process, there are certain quarters in academics and planning which consider slums as a solution to the urban housing problem (Turner 1963, Frieden 1965, Harth Denke 1966, Ward 1976). The idea that slums are a solution to the housing problem is not as outrageous as it was before (Ward, 1976). This is particularly because of the urban experience all over the world which indicates that slums are likely to continue as an integral part of urban growth. However, even if one considers slums as inevitable and as a solution to urban housing problems, the fact remains that they have negative impacts on the health of the population living in and around them. Their emergence and growth lead to several problems of city administration. These autonomous actions of low income groups and slum developers have reduced the sphere of influence of urban planners so that urban planning is restricted to planning for high/middle income groups (Turner, 1968).

Solutions to these problems will essentially depend upon whether we perceive slum as a problem of the non–slum population or as a problem of the slum population. The former perception which has its roots in middle class standards and attitudes would lead us to negative responses and slum clearance schemes. Such a route is not practical, since, in the present situation, slums are likely to grow at much faster rates than they can be cleared. Such a route to the solution of the slum problem becomes complicated when we consider the political interventions, and the administrative difficulties faced by concerned authorities.

The latter course would lead us towards slum improvement programmes, the success of which may result in accelerated growth of slum population (Achwal, 1979). While on the one hand the meagre financial resources inhibit implementation of such programmes, on the other hand, perhaps, the realisation of the possible acceleration of the sluming process due to such programmes, also results in lack of concerted effort in improving slums.

If we were to follow a Marxian framework of analysis, the phenomenon of slums would be an inevitable product of the capitalist mode of production and, therefore, could not be analysed in isolation. The solution of slum problems would be directly linked to changes in the political system. However, it must be realised,

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that although the Marxian framework could be an effective frame for a diagnostic study, policies derived from such an analysis may not be practicable in the context of our present political system.

There are a large number of studies on slums in India and other parts of the world (Dweyer 1974; Perlaman 1980; Saini 1973; Stokes 1962; Turner 1966, 1967, 1968; Ward 1976). A survey of the research literature on slums in India leads us to conclude that the impact of romantic views of slum predominate in understanding slum culture and the underlying 'poverty factor' (Venkatarayappa 1972; Desai and Pillai 1972; Wiebbe 1975, 1981; TCPO 1973, 1975; IIPA 1979; Clinard 1966).

It is apparant from such studies that the characteristics of slum population are distinct from that of non–slum population with reference to a variety of demographic, economic and social indicators. It is also clear that the life style of slum population is different from that of non–slum population. There is also a definite pattern in the locational attributes of slums within a city. What we are reporting here are these differences, locational patterns and growth patterns of slums in Bangalore. The household level data analysed here is based on a survey of 311 households in 11 slums of the city. The survey was conducted in 1973–74 under the city Survey Project (Prakasa Rao and Tewari, 1979). Of the 11 slums 4 were located in the city core, 3 in the intermediary zone and 4 in the peripheral zone. Other sources of information include the Slum Board, and field visits. While, this is a part of a larger on–going study, the ultimate objective is to derive a set of policy guidelines relating to slums in metropolitan cities.

Slums in Bangalore: Size and Growth:

The Bangalore city corporation contained 159 slums in 1971–72, with a population of about 1.3 lakhs accounting for about 10 per cent of the city population (Prakasa Rao and Tewari 1979). It may be noted that the study pertains to declared slums i.e. those declared as slums under the Mysore Slum Areas (Improvement and Clearance Act, 1973). However, compared to other metropolitan cities this proportion is rather low. The number of declared slums increased from 159 in 1974 to 287 in 1982: i.e. an increase of about 85 per cent.

The average population size of a slum was a little over 800 persons. However, the range in size was between 34 to 9000, the most frequent size of slum being 300-600. The spatial distribution of slums is shown in Fig.1. A study of the map indicates that the intermediary zone has the largest number of slums as compared to the city centre and periphery. The intermediary zone was at an earlier stage of city growth, a periphery. Thus, it may be concluded that the present Periphery elects itself as a potential area for further slum sites (Prakasa Rao and Tewari 1979). This is indicated by the pattern of new slums that have emerged between 1972 and 1982 (Fig.2).

The location of slums, also generally, is relegated to sites that are least desirable from the habitat point of view - low lying areas that are susceptible to innundation,

quarry pits, tank beds, along railway lines, near cemeteries, slaughter houses etc. Their locations with reference to other land uses indicate proximity to residential and commercial land uses. And it is these two sections of the urban population that employ the largest number of work force residing in the slums. Although it was found that only 14 of the 159 slums were located near industrial establishments (Prakasa Rao and Tewari, 1976) we cannot conclude that industrial development is unrelated to slum growth. While many of the industries in Bangalore call for skilled labour and technicians, the necessary services related to the industrial population have to be provided, so also the labour required for consequent increase in construction activities. The unskilled labourers in such services find their residences in slums.

In Table I we have recorded the nature af ownership of land on which the slum are located. Privately owned lands in general, are the largest victims of slum encroachment. The perference for private land has further accentuated within the decade wherein the growth in the number of slums was 151%. No category of land owner has been spared - each category registered a growth in the number of slums.

Since we also know that many of these new slums are on the periphery, on revenue land/notified area, it may be worthwhile to study the relationship between such slum encroachment and absentee landlords in the case of privately owned lands and the land earmarked for public utilities in the case of govrenment land.

Other than the natural growth and growth by accretion in the existing slums (in 1972) there has been a growth of about 1.1 lakh of population in the new slums, assuming an average size of the slum at 800. Assuming 40% growth in the slums of 1972, and the additional population of about 1.1 lakhs in the new slums we arrive at a figure of about 300,000 slum population in the corporation limits which works out to 13% of the city population,

The slums in Bangalore occupy an area of 3,451 acres (National Sample Survey, 1980) which is about 11% of the corporation area. In the city core, lack of space and higher land values restrict the slum households to single room structures. On the other hand, the slums in the core being chronologically older are more stable in terms of tenureship/ownership. Although one execpts, in contrast, that slum households in peripheral areas of the city will occupy more space per household, one finds that this is not so. The risk of demolition in the wake of the dangers of slum development and the functional requirements of slum household in general have kept the slum areas in peripheral part at lower unit areas standards (Table 2). The intermediary zone which housed slums a few years ago had the opportunity of available space at a time when risk of eviction and demolition was less and consequently is characterised by more spatious dwelling unit.

Since the growth of slum is dependent among other factors on the availability of open space we find a negative association between general population density and slums (Table 3). Secondly, since densities are negatively associated with income,

we find slums interspersed with high and middle income areas. Such associations are also conducive to the fact that a significant part of the slum work force is employed in domestic and other related activities.

Slum as a product of migration

If we define migrants as those who were not born in Bangalore city but were residing in the city at the time of the survey, the migrant households constitute about 60% of the total slum households. It would therefore appear that slums are basically a product of migration into Banglore. In the city, as a whole also, 62% of the population were found to be migrants. In this respect, therefore, resident/migrant ratios are similar in the slum and the non–slum areas of Bangalore.

Migrant respondents in the slums originated entirely from the southern states. In order of importance, the states of origin are – Karnataka (46%), Tamil Nadu (36%), Andhra Pradesh (15%) and Kerala (1%). Migrants originating from Karnataka are further restricted to the southern districts. This trend howere, seems to be changing with people migrating from the northern districts of Bidar, Raichur and Gulbarga. These migrants (mostly tribals) are of recent origin, some settling in exclusive slums of their own and finding employment in construction activities based on field visits.

Low incom job seekers are more dominant among non – Karnataka migrants as indicated in Table 4. What is clear therefore is that the migration has not just merely swelled the ranks of unskilled labour force in the city but also of the skilled, educated and high income status population.

Apparently the sources of migrants whether they live in slums or otherwise are similar. But a greater proportion of the migrants in non–slum areas are accounted for by people who migrated from within the state as compared to migrants living in slums.

It is also found that urban migrants predominate the non–slum areas (52%) and rural born migrants in slums (53%). Therefore, the growth of Bangalore cannot be succesfully explained by the push factor operating in its rural hinterland. Even in the slums, the fact that 47% of the migrants were urban born is significant. Step migration in general was found to account for only a small proportion of the migration stream. Only 10% of the migrants in slums came from places other than the place of birth, while the corresponding value for non-slum areas was 24%. The low proportion of step migrants has also been noted in Madras slums (Wiebbe, 1981).

While it is obvious that the major reason for migrating into cities is employment the percentage of job seekers among the migrants was 76 per cent in slums as compared to about 25 per cent in the non-slum areas. In the non-slum areas the percentage would increase if we considered migrations because of transfers and those who migrated after acquiring employment.

A majority of the job seekers in the slums found some form of occupation within a month of their arrival in the city. While a significant proportion of their occupation was casual in nature, on an average they could find employment for about 20 days in a month.

It is generally believed that there is a dominance of male adults in rural-urban migration streams. The data for Bangalore, however, reveals that only 40% of the migrant respondents in the slum areas came alone at the time of migrating. However, in the older slums of the city core the proportion of respondents who came alone is significantly higher than in the more recent slums of the intermediary and peripheral zones (Table 5).

The age–sex distribution of migrants, therefore, is undergoing a change and the towards the migration of the entire family. This is more trend is so with the low income – unskilled labour force that moves into city slums. Such a trait is possible because the occupations in which such migrants are engaged are casual in nature and a larger part of the family unit is employable. Secondly, it is also clear that such employments are available within a short time of the migrant's arrival in the city. Apparently, for such employments, one perhaps does not require earlier contacts or help. This is indicated by the fact that 80% of the respondents came to the city without any help. However, the migrants who come without finding help do find employment relatively easily as compared to their finding a dwelling place. Necessarily, therefore, such migrants have to pass through a stage of 'pavement dwelling' before they get a foothold in slums. Once the process starts, there is an inherent tendency for the slums to upgrade themselves with time and permanancy.

With the passage of time, not only does the slum population gets established, but their links with native places also weaken, till they are ultimately cut off from the place of birth. This is indicated by the fact that only 42% of the respondents in the older slums of city core establish contacts with their native place through visits and other transactions. Corresponding values for intermediary and peripheral zones are 48% and 60% respectively.

Although the slum dwellers are among the poorest among the urban population groups, they seem to have substantively improved their economic condition as compared to their pre–migration conditions (Table 6). Whether, such enhanced incomes have resulted in better living conditions is still an un–answered question.

Earnings and Occupations of Slum Dwellers

Despite such marked differences in the income before and after migration, the fact remains that the slum dwellers in Bangalore are in the lowest income group, largely engaged in the informal sector (Table 7 and 8).

While the distribution of households by income is quite dissimilar in the slum and non–slum areas, there are broad similarities in the pattern of expenditure. They are :

(1) proportion of expenditure on rent and education by the slum households is very low. Although much of the dwelling units are unauthorised and illegal, over 95% of the units are owned rather than rented. Similarly the school enrolement rate is also low. Only 57% of the children in the age group of 0–14 were reported to be attending school ; and

(2) a higher proportion of expenditure of slum households is on food, fuel, health and clothing.

While this pattern of expenditure is similar in slums located in various zones there are noteworthy variations. For example, one finds that a relatively larger portion on entertainment, liquor and health care services.

Since the slum dwellers are associated with low status, low income occupations, it is to be expected that the participation rates would be higher. Bangalore slums reveal such a pattern wherein the workforce as a percent of total population is 32.3 per cent as against the corresponding value of 26.2 per cent in the case of the non-slum population of the city. Consequently, slums record a significant incidence of child labour-10 per cent of the children in the age group of 0–14 as against 1 per cent in the case of non-slum areas.

It is necessary to note that the age distribution of population between slum and non-slum dwellers is dissimiar (Table 10). The fact that a larger proportion of slum population is in the age group of 0–14 implies not only larger number of child labourers, but also the growth of slums through natural growth over time. Similar age-structure has also been noticed in the other squatter settlements (TCPO, 1975).

Summary and Concluding Remarks

The growth of slums in Bangalore as elsewhere is directly related to the growth of non-slum population. There is little relationship between slum population and industrialisation of the city. However, skilled work force that grows along with the growth of industrial establishments requires services that are generally performed by unskilled illiterate and low income population. There is, therefore, a functional linkage between slum population and non-slum population thus creating demand for slums. This results not only in the accelerated growth of slums but also the pattern of distribution follows that of the general population. We cannot, therefore, have a policy of decelerating slum population growth without corresponding deceleration of non-slum population growth. Even if the city population growth is reduced considerably, the back log of construction activites for house of 50,000 (estimated shortage of dwelling units in Bangalore in 1971 which in all probability has increased further) families and the natural growth of population will lead to continued growth of slum population.

The nature of occupations and commuting costs lead to the location of slums close to the place of work. The average commuting distance for work of workers in

Bangalore slums was 2.8 km for males and 1.6 km for females. Consequently, slums are interspersed with commercial and residential areas. If we accept the fact that the slums are inevitable, we are then forced to bring them within the ambit of urban planning and plan them as an integral part of the residential layout. Similar policy requirements have been expressed by others (Bhattacharya 1979).

In this context it is worthwhile to consider provision of community infrastructure like electricity, water, sanitation, school and health care centres, rather than any public investment in housing. This is particularly important because if the investment is on creating better dwelling units, the slum population would be deplaced by low/middle income groups and the slums would appear elsewhere. Recent surveys of HUDCO financed houses showed that 73% of the house constructed for economically weaker sections were in reality occupied by low income groups and the houses constructed for low income groups were in turn occupied by middle income groups (Iyer 1982).

It is clear from the attitude of the the slum population, that while relocation of slums is resented, the attitude towards shifting into multistoreyed stuctures is more positive (Tale 11). One strong reason for multistoreyed tenement structure for rehousing slum population is the relative cheapness of per capita costs of providing infrastructure and the saving in open space due to the very high densities achievable through multistoreyed tenements. Although, there have been questions about the suitability of multistoryed structures for slum dwellers in view of their indulgence in animal husbandry and poultry, we find in Bangalore slums that only 4% of the households practice animal husbandry and/or poultry.

However, slums in the peripheral areas and slums *in-situ* (village based slums) record higher proportions of households owning farm animals and fowls. This is also reflected in the substantive reduction of respondents willing to move into multistoryed tenements in the peripheral zone.

On the other hand, the major hurdle in resettling the slum dwellers in multistoreyed tenements is the high cost of construction that has necessarily to be met by local administrative bodies. Experience in the Madras slum resettle tenement projects has shown that even if the rent is affordable from the dwellers point of view, the recovery rate is very poor (Sampath, 1913; TCPO 1975). As indicated earlier, much of such facilites created do not reach the target group.

The slum improvement programme have also not been successful. The meagre resources that are available for slum improvement do not even make dent on the slum problems. The misguided investments in creating woefully inadequate baths, toilets, street lights etc., have had no tangible impact on the sanitary conditions of the slum neighbourhood. The norms that we have in Bangalore are comparable to other cities – 1 toilet for 20-50 persons, 1 bath for 20 families and one street light for every 100 feet (Shivalingappa, 1979).

When we see that several applications are pending with the slum board for declaration of slums, it is not because the population in these slums are eager to avail of these facilities, but only to reduce the risk of eviction demolition. The conditions set for declaration of slums, themselves, in a way, encourage insanitary conditions. The conditions, provided for in the Mysore slum areas (Improvement and clearance Act, 1973) reads as follows :—

where the Government is satisfied that, –

(a) any area is or is likely to be a source of danger to health, safety or convenience of the public of that area or of its neighbourhood, by reason of the area being low-lying, insanitary, squalid, over-crowded or otherwise ; or

(b) the buildings in any area, used or intended to be used for human habitations are –

(i) in any respects, unfit for human habitation ; or

(ii) by reason of dilapidation, over crowding, faulty arrangement and design of such buildings, narrowness or faulty arrangement of streets, lack of ventilation, light or sanitation facilities, or any combination of these factors, detrimental to safety, health or morals.

It may, by notification, declare such area to be slum area.

For purposes of declaration, therefore, the slum dwellers would try to meet these conditions and thereby increase the level of insanitary conditions. It is therefore worthwhile to consider a minimum level of sanitary conditions for declaration of slums. This also implies in principle, conditions for de-declaration of slums if environmental conditions reach a dangerous level leading to possible relocation/ demolition.

The foregoing analysis also brings out some difference in household attributes between Bangalore's slum and non-slum population. From these differences one may note the significance of changing age-sex structure of migrants in slums. The results of the analysis also indicate that the slum population is likely to use more of certain urban infrastructure like water and health facilities and less of other infrastructure like transport, entertainment and educational facilities.

Government land earmarked for public utilities, in peripheral areas, less suitable for human habitation, private lands characterised by absentee landlords are potential sites for future slums. Although the area occupied by slum households is only their minimal reqnirement, the total area occupied by them may amount to over 10 per cent of the Bangalore corporation area. Just as Bangalore's population density is low compared to other metropolitan cities, population densities in Bangalore's slums are also lower compared to the other metropolises (National Sample Survey, 1980).

The impressions that we get from field visits are :

(a) The houses in the slums are clean and neat but the exterior is filthy.

(b) The slums are at various levels of improvement and hygenic standards.

(c) Some of the mobile slums associated with construction work gain permanancy if the site characteristics are conducive. However, since these slums are not declared, we have no details of the machanics of the formation of slums of this type.

(d) That slums are still looked upon as a neighbourhood problem rather than as city level problem.

The slum board generally has a tendency to perform as disbursement agent of avaiable funds for slum improvement projects and there seems to be a lack of any long term perspective or plan of action. It is necessary to remind ourselves that physical improvement alone is inadequate in the context of city slums particularly when we have no general policy towards slum growth or urbanization for that matter. As said earlier, so long as there is a demand for the low status, occupations consequent upon city growth, slums will flourish and their distribution within the city will be similar to that of the general population. Under such circumstances, the city planners will be better off by bringing slums within their ambit rather than shying away from them.

REFERENCES CITED

Achwal M B (1979) Environmental Improvements in Slums, in *Slum Clearance and Improvement, IIPA, New Delhi.*

Blomkvist H (1982) *Spontaneous Settlements – A Problem or a solution?* (Mimeo) University of Uppsala.

Clinard M B (1966) *Slums and Community Development.* The Free press, New York.

Desai A B and S D Pillai (1972) *Profile of an Indian Slum, Bombay,* Bombay University.

Dwyer D (1974) Attitudes Towards Spontaneous Settlement in Third World Cities, in *The City in the Third World,* D Dwyer (ed.) MacMillan, London.

Frieden B J (1965) The Search for a Housing Policy in Mexico City, *Town Planning Review,* 36, 75-94.

Harth-Denke J A (1966) The colonies proletarias of Mexico City - Low income settelment at the Urban Fringe. Master's thesis MIT, quoted in ward (1967).

IIPA (1979) *Slum Clearance and Improvement, IIPA, New Delhi.*

Iyer V S K (1981) Solving the Housing Problem in Bangalore City : Some Suggestions, *Discussion Paper, Indian Statistical Institute,* Bangalore.

National Sample Survey (1980), *Special Survey of Living Condition in Slums*, NSS No. 290, NSS, New Delhi.

Perlman J (1980), The Failure of Influence : Squatter erdication in Brazil in *Politics and policy Implementation in the Third World* M S Grindle (ed.) Princeton, University Press, Princeton (N. J.)

Prakasa Rao T L S and V K Tewari (1976) *Bangalore–an Emerging Metropolis*, ISEC (Mimeo), Bangalore.

Prakasa Rao V L S and V K Tewari (1979), S*tructure of an Indian Metropolis–Bangalore*, Allied, New Delhi.

Saini B S (1273), Slum Improvement and Squatter Rehabilitation : The Calcutta and Bombay Experience, *Design*, Vol. 17, 27–31.

Sampath E V K (1983), The Housing Problems of the Low Income Groups – Tamil Nadu Experience of Slum Improvement, paper presented at the seminar on problems of Low Imcome Group in metropolitan Areas, Osmania University.

Shivalingappa B K (1979) Slum clearance in Bangalore : Problems and Programmes in IIPA *opcit*.

Stokes C J (1962), A Theory of Slums *Land Economics*, 38, 187–97.

TCPO (1973), *Jhuggi Jhonpuri Settlements in Delhi Part I*, Government of India, Town and Country Planning Organization, New Delhi.

TCPO (1975), *Jhuggi Jhonpuri Settlements in Delhi Part II*, Government of India, Town and Country Planning Organization, New Delhi

Turner J F C (1966), Uncontrolled Urban Settlement : Problems and Policies in *The City in Newly Developing Countries* G Breese (ed.) Prentic Hall Englewood Cliffs (1969)

Turner J F C (1967), Barriers and Channels for Housing Development in Modernizing Countries, *Journal of the American Institute of Planners*, 33, 167-81.

Turner J F C (1968), Housing Priorities, Settlement Patterns, and Urban Development in Modernizing Countries, *Journal of the American Institute of Planners*, 34, 354–63.

Ward P (1976), The Squatter Settlement as Slum of Housing Solution : Evidence from Mexico City, *Land Economics*, 52, 330-46.

Wiebbe P D (1975), S*ocial Life in an Indian Slum*, Vikas New Delhi.

Wiebbe P D (1981), *Tenenents and Trustees A Study of the poor in Madras* MacMillan, Delhi.

Table 1 : Distribution of Slums by Land Ownership

Ownership	No. of slums		% increase
	1972	1982	
Corporation	36	63	75
Government	13	17	31
Private	57	143	151
BDA (CITB)	42	64	52
Unspecified	11	—	—
Total	159	287	85

Table 2 : Slum Hutment Sizes by Zones

Zones	% HH with one room	% HH with more than one room	% HH with floor space of	
			150 sq.ft. and below	150 sq. ft.+
Core	63	37	62	58
Intermediary	38	62	58	42
Periphery	59	41	74	26
All Zones	54	46	66	33

Table 3 : Distribution of Slums by Population Density of the Census Division of their location.

Density of Population per acre	No. of Slums
Less than 50	77
50 – 100	33
100 – 200	31
200 – 300	11
300+	2
Total	154*

*5 Slums were outside corporation limits.

Source* Prakasa Rao and Tewari (1979).

Table 4 : Distribution of Migrants in Slums and Non-Slum Areas by origin*.

Origin (States)		Slum Areas	Non-Slum Areas
Andhra Pradesh	....	15.0	7.6
Karnataka	....	46.0	57.9
Kerala	....	1.1	8.1
Tamil Nadu	....	36.4	21.3
Others	....	1.5	5.2
		100.0	100.0

*Based on field visits.

Table 5 : Percent Migrant Slum-Respondents who migrated alone to Total Migrants in Slums.

Zones		Respondents who came alone
Core	....	51
Intermediary	....	36
Periphery	....	39
All Zones	....	42

Table 6 : Percent Earners in Different Income Groups Before and After Migration

Income per month (Rs.)		Before Migration	After Migration
Below 50	....	64.3	9.5
51 – 100	....	28.0	28.5
101 – 200	....	5.6	51.8
200+	....	2.1	11.5

Table 7 : Percent Households by Income Groups in Slum and Non-Slum Areas.

Income per month (Rs.)		Slums	Non-Slum areas
Below 300	....	80.2	24.4
300 – 500	....	16.6	27.0
500+	....	3.2	48.6
Mean Income per HH	....	206.32	657.3
Monthly per capita income	....	34.91	133.0

Table 8 : Percentage Distribution of Earners by Occupations.

Occupation		% Earners
Professional workers and contractors	....	1.85
Clerical and sales workers	....	12.71
Service workers	....	18.39
Farmers and loggers	....	1.84
Construction	....	18.73
Cooly	....	13.54
Basket, Agarbathi making	....	4.85
Mechanics	....	5.52
Cartmen, drivers, Cleaners	....	5.18
Other production workers	....	17.39
All occupations	....	100.00
Number of earners	....	598

Table 9: Expenditure pattern of Households in Slums and Non-Slum Areas

Items	% Expenditure to Total Expenditure	
	Slum HH	Non-Slum HH
Food	69.6	57.6
Fuel	10.5	6.2
Clothing	7.0	4.0
Education	1.4	3.5
Health	3.3	1.7
Rent	0.9	7.1
Others	7.4	19.9
All Items	100.0	100.0

Table 10 : Age–wise Distribution of Population in Bangalore

Age Group	Percent Population in	
	Slums	Non–Slums
0—14	43.1	37.2
15—59	51.9	57.5
60+	5.0	5.3
Total	100.0	100.0

Table 11 : Percent Respondents Willing to Relocate and Resettle

Zones	% respondents willing to be relocated	% respondents willing to move into multistoreyed tenements
Core	18.7	52.1
Intermediary	25.3	51.8
Periphery	19.5	40.6
All Zones	20.8	47.1

MOSQUITO CONTROL IN BANGALORE CITY SOME OBSERVATIONS

T. RAMACHANDRA RAO

1. Introduction

Mosquito nuisance in Bangalore city (population 2.9 million – 1981 census, has been very serious in recent years. A city, otherwise noted for its salubrious climate and a pleasing environment is nowdays plagued by swarms of mosqutios, particularly in the eastern and southern parts. The City Corporation is doing its best to combat this menace but without much success. Recently it has taken a few important steps, such as elimination of some tanks, which are bound to improve the situation to a better extent. But the problem is much greater than what appears simple at first sight. I was requested by the Commissioner of the Corporation and the Health Officer (Dr. S. Upadhyaya) to make a general study of the problem and to suggest methods of combating this menace. I have spent about six months on this work and I am glad to furnish this report. The KSCST has also encouraged this effort.

The major source of nuisance is *Culex fatigans* which breeds internally in the tanks and drains of the city. It is prevalent throughout the year but most abundantly in the months of March, April and May. In addition, there is a subsidiary nuisance caused by the day biting *Aedes aegypti* particularly in the rainy season. There are several other species of *Anopheles and Culex*, but they are not of much significance.

It is generally accepted that the degree of nuisance by *Culex fatigans* has considerably gone down during 1975. This has been ascertained by many personal enquiries made from residents in such localities as Jayanagar, Wilson Garden, Basavanagudi, Chamarajpet, Ulsoor and Indira nagar. The relief obtained has been widely acclaimed. It would not, however, be possible to say how permanent would be this reduction. Moreover, the degree of nuisance, which continues to persist, is still considerable and the potentialities for aggravation are still there to make it imperative to pursue the matter further in order to have a mosquito nuisance–free Bangalore.

All the causes for the lower degree of nuisance in the year 1975 are not clear, but a few actions taken by Corporation have undoubtedly contributed substantially ; particularly –

1. Breaching and drying of a few tanks and diversion of the sewage water away from a few other tanks ;

2. Strict steps taken to minimize unauthorised grass cultivation ; and

3. Tightening up of the day to day control measures and the easier availability of larvicidal oil supplemented by the use of pyrethrum products in emergencies.

Nevertheless, in would be unwise to minimise the existing problems and not to foresee the new problems that may arise. It is essential that a scientific study of the whole problem be made so that not only a long term plan is made, but the existing machinery works to optimum capacity. The excellent record of 1975 should be consolidated and improved upon.

The sources of funding for the anti–mosquito work in the City are :

1. The funds provided by the Corporation as a regular feature of its annual budget : (Rs. 24.0 lakhs in 1975–76)

2. The aisistance received from the NMEP under the urban malaria control scheme : (Rs. 5.0 lakhs in 1975–76)

plus about Rs. 4.0 lakhs being cost of free oil supplies, marking a total of Rs. 33.0 lakhs.

The total area of Bangalore Corporation is about 49.2 sq. miles and of the extended areas included in the metropolitan area is 145.0 sq. miles, marking a total of 174.2 sq. miles. The population in the 1971 census in the Corporation area was 17.54 lakhs and of the extended area 5.20 lakhs, making a total of 22.74 lakhs.

2. The Causes for Mosquito Nuisance

Bangalore City at present gets about 54 million gallons daily of water which is expected to increase soon to 64 MGD. The water supply comes from the following sources :

1. The old supply from Tippagondanahally and Hesarghatta reservoirs–34MGD
2. The new supply from Cauvery Project (Stage I) - 30 MGD.

Till early 1975, the supply was only from the old sources. Proposals are under way further to augment the supplies from both these sources, and ultimately a total supply of 94 MGD is anticipated when the Cauvery Project Stage II is completed.

In addition, the City gets an average annual rainfall ranging from 35 to 39 inches at different places, mostly distributed in the months of June to October with a few pre–monsoon showers as well as a slight drizzle during the North East monsoon in November and December.

It is the indequacy of the overall system for the disposal of the water from all these sources that is responsible for most of the mosquito nuisance in the City at present.

Most of the sections of the City are served by an underground drainage system, but there are many areas particularly in the slums and new private layouts where there are no underground sewers. Except in a few of the major natural drainage

valleys, the sewer lines are not yet laid till beyond the boundaries of the City but have outfalls well within the urban limits forming large open nullahs. The sewage of the City is led into a few tanks within or very close to the city. Sometimes the sewage water is used illegally for agricultural purposes. Many storm water drains are perennially wet because of the practice of letting domestic waste water into them. Thus, though plans have been made for a fairly complete drainage system for the city, it does not serve it completely yet. The entire system of waste water disposal has provided factors conducive to the breeding of *Culex fatigans* which has a strong liking for organically polluted water. These features are not peculiar to Bangalore City, but have become a common feature in all large urban areas in India. But unlike in most of them, Bangalore City has been endowed with favourable natural gradients which would ensure quick drainage of waste water, if the drains are well designed and maintained.

The main sources of *Culex fatigans* in Bangalore City can be classified as follows :

1. Open nullahs carrying sewage ;
2. Storm water drains ;
3. Tanks ;
4. Wet cultivated lands ;
5. Wells – agricultural and domestic ;
6. Quarry pits ; and
7. Miscellaneous, such as borrow pits, cess pools, septic tanks, cisterns, fountains, etc.

In the absence of dependable information on their actual numbers, lengths, areas etc. it is not feasible, at present, to make precise estimates of their relative importance as sources of mosquito nuisance. However, based on whatever information is available and shrewed personal assessments, it can be said that nullahs and drains of various types, tanks and wet cultivation, particularly the growth of grass, put together, contribute to the bulk of the nuisance. Such estimates, if precisely made, would help in choosing priorities for attention and also for studies on cost benefits to get the maximum benefits from the funds available. Unfortunately, such data are not available, though the Corporation authorities have made a few assumptions in the past.

The problems posed by each of these types of breeding places may now be briefly discussed.

1. Nullahs

Though the major part of the city has underground sewers, there are many sections which still are not served by them, particularly in slums, newly made private

layouts, the large industrialised area around but very close to the city, etc. In such areas, the entire sewage flows into the natural drainage channels which are neither lined nor properly treated. Moreover, the main sewers have been laid upto and beyond the urban limits only in three of the six major valleys, viz., Chellaghatta, Koramangala and Vrishabhavathi. The other valleys viz., Hebbal, Kathriguppa and Tavarekere (Madivala) valleys are yet to be covered. There are also a few other minor valleys such as the Arkavathi Valley in the West which still need the main sewer lines. The entire sewage of these valleys is now carried by kutcha nullahs. In the Hebbal Valley, however a large stone lined box shaped drain has been built near Gangenahally. These can all be sources of mosquito breeding along the edges where there is no current or in the side pools.

2. Storm water drains

Storm water drains, large and small, are found in all parts of the city and many of them also carry domestic waste water and waste water from public taps. While they were built to carry away the rush of rain water, they are inefficient to carry away the trickles of waste water from houses. The gradient in cases is not enough for smooth flow of water nor is the water enough to flush away the debris. This is made worse by the indiscriminate throwing of rubbish into the drains and the natural accumulation of silt. Though the Corporation does attempt to clear these drains at least once before the monsoon, it does not serve the purposes of mosquito control. Water stagnates in many of these drains particularly on the roadside.

There are many open storm water nullahs which often flow parallelly to the main underground sewers. They carry both storm water and the waste water from house and business establishments. In addition, they are contaminated by night soil, because of the prevalent habit of people using them as places for defecation. While some of the major nullahs are stonelined or cementlined, there are many which are not lined at all. Even the stonelined drains either do not have a cuneate and even if one is provided, the same is often clogged up and there are numerous puddles and accumulation of water on the sides. These are good breeding place for *Culex fatigans*.

Many of the drains are also permanently covered by stone slabs either for aesthetic or safety purposes making regular inspection and cleaning impracticable. There are miles and miles of these so called "box drains" within the city. Each drain, by itself, may not be a big source for mosquitos, but the total output from all drains can be substantial and they provided enough numbers of mosquitos to create nuisance in their proximity.

3. Tanks

There are nearly 50 tanks, small and large, within or just outside the City. At present, some are purely ornamental, but most are irrigation tanks with varying degrees of wet cultivation under them. In the past, most of these tanks were getting filled with rain water only and tended to dry up considerably during thc non–mon-

soon months. But the enormous quantity of waste from the city's water supply now keeps these tanks perennially full. Except perhaps the Sankey's tank in Malleshwaram, all other tanks are sources of *Culex fatigans*. While normally, irrigation tanks even with vegetation are not good breeding places for *Culex fatigans*, though they may breed other species of mosquitos, the tanks within and around the city have now become prolific sources of *Culex fatigans* because they are contaminated by sewage or night soil. Almost every tank gets some amount of sewage. It is also to be noted that with the phenomenal increase in the population of the city and the development of new suburbs, many tanks, which at one time, were away from the urban influence, have now become involved in the sewage disposal system. This has greatly added to their mosquito breeding potential.

A list of the tanks examined and the intensity of mosquito brceding found in them in July/August 1975 is given below :

Name of tank	Intensity of breeding	Remarks
Kengeri	Moderate to extremely heavy	Throughout
Kenpambhudhi	Light to moderate	Discontinuous
Sankeys	No breeding	—
Siddaguntana palya	Light to moderate	Discontinuous
Yediyur	Light to moderate	Discontinuous
Belandur	Extremely heavy	Throughout
Byrasandra	Moderate to heavy	Discontinuous
Challaghatta	Light to heavy	–do–
Lalbagh	Moderate	–do–

Note :

Light	....	less than 10 larvae per dip
Moderate	....	10 to 50 larvae per dip
Heavy	....	50 to 100 larvae per dip
Very heavy	....	100 to 500 larvae per dip
Extremely heavy	....	Over 500 larvae per dip

It will be noticed that Belandur tank, which has a surface area of over one sq. mile, to the South-East of the City, was the most prolific source of mosquitos. Heavy breeding in this tank is due to the discharge into it of the entire effluent from the city's main drainage in the Challaghatta valley. Even after the recent installation of the large sewage treatment plant, all thc treated effluents from the plant as well as a good proportion of the untreated sewage flow into this tank.

There is an impression that the effluent from the sewage plant is comparatively safe. It would be true so far as the bacterological hazards are concerned, but the effluents from such plants would still be highly attractive to *Culex fatigans*.

Modern treatment plants are now installed in Challaghatta (including Koramangala) and Vrishabhavati villeys, but still not in the others. The raw sewage flows into practically every tank in the periphery of the city and flows down from tank to tank in the same valley.

The influence of tanks on mosquito nuisance is both intensive and extensive. They not only produce intense mosquito nuisance in the vallages or suburbs in close proximity, but because of the abundance of the output of mosquitos and well known flight range of *Culex fatigans*, they can produce considerable nuisance even in localities which are two to three miles away. Therefore, tanks need very special attention in any overall plans for mosquito control.

The problem of tanks is aggravated by the growth of water hyacinth in a few of them. While the elimination of water hyacinth from the tanks can be justified for more than one reason, its exact relationship to breeding of *Culex fatigans* needs to be critically evaluated. It is not clear whether the presence of water hyacinth by itself is the cause of breeding of the *Culex fatigans*. It is mainly the the contaminated water of tanks which attracts these mosquitos. It would perhaps be not incorrect to say that it is the high degree of pollution of such water that is the common cause for *Culex* as well as water hyacinth. The excellent shelter provided by the hyacinth growth helps in protecting the larvae and therefore adds to their abundance.

4. Wet cultivation

A considerable area of wet cultivation occurs under all tanks in the vicinity of Bangalore City. As the tank water is contaminated by sewage, the irrigated lands also become favourable breeding places for the nuisance mosquito if standing water is allowed. However, it is the unauthorised utilisation of sewage water for cultivation of grass in many of these valleys which is one of the serious causes for mosquito nuisance. This has been considerably reduced last year because of the strict action taken by the Corporation. Still it is understood that certain sections of the Municipal bye-laws comes in the way of their complete elimination.

5. Wells

It is said that there are over 12,000 wells in Bangalore Corporation area. No estimates are available regarding their number in the whole metropolitan area, but one can safely surmise that there are at least an equal number, if not more, in the extended areas. These 25,000 wells or so constitute an important source of mosquito nuisance. Some of them are used for either domestic or agricultural purposes, but many of them are disused. Wells with clean water are not attractive to *Culex fatigans*,

but when they are contaminated by sewage, they become prolific sources. In a survery made in 1975, 42 out of 276 wells examined were found to be breeding. The influence of the wells. however, is rather local. At the same time, it is worth keeping in mind that wells are also the source for the malaria carrying mosquitos of the urban areas, viz., *Anopheles stephensi.*

6. Quarries

There are over a dozen large quarries within and just outside the city. They are sources of nuisance because their water is also contaminated not only by trickles of sewage water which flows into them, but also because they are contaminated by night soil. The shelter provided by the quarries induce people to use them for defecation. These quarries, like wells, even if they are not contaminated with gross organic matter would be serious health hazards because they would be good breeding places for malaria carrying mosquitos, particularly *Anopheles stephensi and A culicifacies.*

7. Miscellaneous

Under this category are a large number and assortment of breeding places, mainly man–made, as for example, over-head water tanks, cement cisterns, fountains, borrow pits made in low lying areas, brick pits, cess pools, septic tanks, etc. They are usually purely local sources of mosquito nuisance and present no special problems.

Cess pools and septic tanks are a result of the absence of underground drainage. It is well known that they can be prolific sources of the nuisance mosquito. Their numbers and localities are not well known as they are particularly prevalent in the outlying areas with industrial establishments and housing colonies.

III. Control Operations

The practical aspects of mosquito control in Bangalore City can be conveniently discussed under two broad headings, the technical aspects and the organisational set-up.

(A) Technical

General

In cities like Bangalore, emphasis has to be laid on permanent measures which do away with the mosquito breeding places. It does not need any deep study to realize that effective drainage of all water, including rain water, would be the main measure. Every public health worker and public health engineer recognizes it. But few cities make adequate provision for effective drainage simultaneously with the bringing in of water for domestic and industrial purposes. Drainage is perhaps as costly – often more costly – than mere provisions of water supply and therefore generally takes a lower priority. Eeven when an initial provision is made execution of

drainage works lags behind these of water supply and the drainage needs also usually outgrow the original estimates because of the rapid growth of cities. The matter is aggravated in old towns because of the difficulties and costs of modernizing already existing and antiquated systems of sanitation and drainage.

Though conditions in Bangalore City were far better than in most other cities, the problem of drainage has been increasing along with rapid expansion of the city. The severe mosquito problem was a consquence of it. However, the city now has a very progressive combined water supply and drainage project, in which the need for adequate drainage has been recognized. The works are in the process of being executed. The mosquito problems would persist till such time as the entire drainage system is completely overhauled.

With the introduction of the new Cauvery water supply scheme since 1975, the problem could have more serious, but thanks to certain actions taken, the increasing mosquito problem has been more than balanced. This, however, cannot last long because more water is intended to be brought into the city. A deliberate plan to completely eliminate all breeding places by permanent measures has to be taken up and executed as rapidly as possible. At the same time, a point which has to be appreciated is that the waste water has to find a way out. Even if good drainage plans are made and executed and there is no accumulation of waste water within the city limits, waste water has to go outside the city and is bound to create problems to villages lower down the valleys. Some of these would be within the effective flight range of the mosquito to cause nuisance in the adjacent parts of the city. A scientifically designed plan for the use of this waste water, which may be called "liquid gold" for agriculture or horticulture can minimise the risks of mosquito nuisance and mosquito borne diseases, not only in the city, but also in the villages lower down the valleys. Suggestions regarding this would be beyond the purpose of this note. However, perspective thinking on the possible consequence of the flow of the city's drainage water lower down the valleys on the health of the people living in the villages should be taken up as early as possible.

Pending the execution of plans for the complete elimination of the sources of mosquito breeding, recourse has to be taken to temporary recurrent measures. These are costly, time-consuming, repetitive and monotonous and of a type that would not hold interest of the workers for long. With these ideas in mind, a few comments and suggestions are made particularly in respect of the major type of breeding places.

Specific

1. Sewage drains and nullahs

The permanent solution to the problem is converting all open drains carrying sewage into underground drains and extending them to well beyond the city. It would

undoubtedly be expensive, but for a city like Bangalore, it has to be taken up sooner or later. That it can be done only in a phased manner is obvious, but sufficient priority has to be given to it.

2. Storm water drains

It is recognised that storm water drains cannot be put underground, because of the great volumes of water which are to be discharged within hours of downpour. They have necessarily to be large and open but should be so constructed and maintained that they dry up within a short time. The storm water drainage and the sewage system may have to be parallel, but should not mix at all, at least till the outskirts of the city. The storm water has inevitably to be led into the tanks. Bangalore's drainage system need to be thoroughly reexamined from the point of view.

The temporary measures which are needed are :

(a) Keeping all drains clear of obstructions by an efficient and regular system of cleaning ;

(b) converting all kutcha S. W. darins into stone or cement lined drain with proper cuneates, and till that time to canalize them by a regular weekly programme to allow free flow of water and preventing stagnation ;

(c) taking strict measures to prevent domestic waste water from entering the storm water drains ;

(d) applying larvicidal oil on a regular weekly basis to supplement above measures where needed.

Some of the larger S. W. nullahs run practically parallel to the underground sewers, for the simple reason that the sewers are either not adequate to carry all the water or because the sewage lines are damaged. Maintenance of such drains require immediate attention.

Scores of examples of such drains can be given, but just for illustration :

1. The perennially flowing drain which runs between the New Public Offices and the Century Club in the Cubbon Park ; there is no reason why this open drain should exist at all ;

2. Two or three kutcha drains which flow across the Platform Road between the narrow gauge railway level crossing and the underbridge near the City Railway Station.

Obviously, there are either some administrative difficulties or they have just been ignored.

Serious thought has to be bestowed to the proper designing of open drains keeping the needs of mosquito control in mind. For example, the flatbottomed stonelined

open drains are most unsatisfactory from the mosquito control point of view though they may be comparatively inexpensive and quite efficient to carry away storm water. All drains should have a cuneate or be V shaped to carry away trickles of water. All new drains may be properly designed and the older ones improved.

A word on the "box drains" which are a characteristic feature of the city. Though aesthetically they serve a good function to hide the drain water from the public view, and also for purpose of safety in narrow streets, they are a permanent source of trouble. Not only can they not be kept regularly cleaned of accumulated rubbish, they also connot be properly inspected or treated. The earlier they are replaced with underground pipes with proper inspection chambers, etc., the better. Pending elimination of these box drains, larviciding is perhape the only remedy. The ordinary sprayers now in use are inadequate to treat these drains. A few power driven sprayers which can blow mists of oil long distances into the drains are needed. Experiments in this regard may be initiated and at least one power sprayer for each zone may be obtained. Simple power sprayers which can be mounted on wheel barrows are desirable.

3. Tanks

Control of mosquito breeding in large tanks by spraying with oil or chemicals is a hopeless, uneconomical and unrewarding task and is not recommended as a general rule. Spraying from air is prohibitively costly and will need repeated application. All that can be attempted is the oiling of the edges or at best a few yards inside preferably using power sprayers.

Elimination of all tanks within the city limits is a desirable step but because of sentimental or aesthetic reasons or for recreational purposes, some of them would still be required within the city. Some of the tanks may also have to be preserved for storage of water for emergencies in a growing metropolis. The city has not suffered – on the other hand has gained much – by the elimination of some old tanks in the course of years, such as Dharambhudi, Sampangi, Visveswarapurm, etc. The recent breaching of such tanks as Chennamma tank and Siddaguntanapalya tank has also led to very good results. A complete plan for the elimination of all, but a few selected tanks, such as Ulsoor, Sankey's, Lalbagh, etc, is needed. The tanks which remain, should, however, be well preserved. All agricultural tanks would have to remain for the present. Very good results will accrue if the flow of sewage into tanks, which is the single largest cause of mosquito nuisance in the city, can be completely prevented. It is heartening to note that some of the sewage lines have now been laid by-passing some major tanks, for example, challaghatta and Kempambhudi with very good results. However, tanks like Belunder in the South East, Kengeri in the South West, Yeshwantpur and Nagavara in the North, are still receiving sewage either directly or after treatment. Further many of the tanks in inhioited localities have local trickles of sewage from the surrounding

houses. These would have to be completely prevented. The problem posed by the Belandur and Kengeri tanks is a very serious one which requires special attention. Nagavara and other tanks in the North also fall in this category. (Please see how under "wet cultivation").

The growth of water hyacinth in tanks is a problem which does not have any readymade solution. It is a worldwide problem. Recognising that it is the organically rich water which provides the common cause for the profuse growth both of water hyacinth and the nuisance mosquito larvae, good results may be expected when the sewage water is completely diverted from the tanks and they are kept free of organic contamination. Mere hand removal at enormous cost or by use of chemicals are not satisfactory answers. The water has to be made unsuitable for the growth of water hyacinth.

In dealing with the problem of tanks such as Belandur and Kengeri, engineers would have to find methods of completely by passing the sewage effluents which now go into these tanks. The effluents and other untreated sewage can be pumped upto higher points or into neighbouring valleys and distributed to lands for intermittent irrigation. Large areas of land, now depending only on rain, can benefit. This type of project needs close collaboration between engineers and agronomists to determine the best types of crops to be grown, whether the rich effluents can be used as such or have to be diluted so that the soil may not be overenriched, etc. Urgent thinking by the administration on the feasibility of this type of solution is strongly urged. It is an engineer's problem which can certainly be solved. Bangalore City can set an example and demonstrate the methods to hundreds of cities in India.

The Fisheries Department may also be consulted to find out whether these tanks can be made into large fish farms. In selecting the fish for farming, species which by nature are good feeders on mosquito larvae can be selected.

4. Wet cultivation

The illegal use of waste water for grass cultivation within and around the city, as everybody agrees, has to be stopped. If the byelaws of the Corporation require changes to ensure their complete prevention, necessary administrative action would have to be taken. But it is not practicable altogether to do away with the normal cultivation under the numerous irrigation tanks particularly in the peripheral belt. Agronomists would have to think of and devise methods of intermittent irrigation and suggest suitable crops for the purpose. Crops which do not need standing water can be encouraged.

The irrigation channels also become periodically dry if an intermittent irrigation system is developed.

5. Wells

Because of their large numbers, wells need special attention. Complete closure of all wells which are not required for domestic or industrial use, has to be ensured within the Corporation limits. This is required not only for control of the nuisance of mosquitos, but also for long term control of the malaria mosquito namely *Anopheles stephensi*. In case of wells which cannot be closed, the responsibility of keeping them free from mosquitos should be made the responsibility of the owners. Selected wells may have to be preserved for water needs during emergencies and it should not be difficult to keep them free from mosquito larvae. Wells with clean water do not produce *Culex fatigans*. Again, it is only when the well water becomes contaminated by sewage, rotting refuse or night soil that they become prolific sources of *Culex fatigans*. Therefore, any well, which is not closed down, must be adequately protected from contamination. Periodical treatment of wells, particularly disused wells, by chemicals is possible, but is not advisable. The best way of dealing with wells is by the use of larvivorous fish. A well organised programme of stocking wells with fish is entirely feasible. A separate paragraph about fish is given below.

6. Quarries

Qurrries are serious problems because they cannot be drained away and the filling of the quarries with the town rubbish, etc. would take a very long time. However, all the different pits at different levels in any large quarry should be connected together for the water to drain into only one large pit. Then it would be easier to treat only the large pit.

No new quarries should be permitted and the existing quarries within the Metropolitan area should be discontinued.

Such of the quarries as are suitable can be used as hatcheries for gumbusia fish. Even some of them can be used for cultivation of edible fish. The help of the Fisheries Department can be sought in this regard.

Again, it is most essential that water in the quarries is not contaminated by sewage or by rotting refuse. All quarries should be suitably fenced and guarded to prevent people from using them for defecation purposes. Periodical oiling can be resorted to, only if necessary. If such oiling is needed, it is not enough to spray only the edges. Power sprayers which can throw oil to some distance on the water surface are needed.

7. Miscellaneous types

There are many of these. It is difficult of give detailed suggestions. Breeding in ornamental fountains, cement cisterns, etc. at the ground level can be easily controlled either by periodical oiling or by stocking them with fish. A strict control of the overhead cisterns, water tanks, etc. should be enforced. It may be

considered whether action cannot be taken by the Municipal Bye–laws to insist that every house owner with a overhead tank should have it properly mosquito proofed as has been done in Bombay City. Such a step is essential not only for the control of nuisance of mosquitos', but also for prevention of breeding of *Anopheles stepensi*.

Cess pools, if they cannot be eliminated, have to be oiled. The problem of septic tanks can be tackled, if all owners of the septic tanks are made responsible to make them mosquito proofed, a step which does not cost more than a few rupees. Septic tanks are generally found in large establishments and houses, the enforcement of the rule should not be difficult. The staff of the Anti-mosquito section should make a list of all such septic tanks and take necessary action.

8. Use of fish

Gambusia fish has been in use in this country for nearly 50 years. It has been used extensively in all parts of India. Experience in many parts of the country has shown that this is the method of choice for the control of mosquitos in small breeding places such as wells, fountains, cisterns, etc. However, it does not have any use in large reservoirs of water, in irrigation channels, etc. While its utility under special conditions has been proved, some doubts have been raised recently whether it would be desirable to extend the use of gambusia fish because it is a voracious fish which eats not only mosquito larvae, but also the young ones of other edible fish, particularly carps. In the long period during which it has been in use in this country, no adverse reports have been recorded. But there is a theoretical possibility of an adverse effect on the large scale cultivation of edible fish. Therefore, it is desirable that fisheries experts may be requested to study this matter, particularly in view of the efforts which are being made by the Government for the large scale cultivation of larger edible fish in inland waters. It has been the experience that ecologically gambusia would disappear from larger water collection because they themselves are devoured by the larger fish.

A special technically competent team for handling gambusia fish should be formed and entrusted with the responsibility for stocking wells. They should periodically visit each and every well under a regular programme, examine whether the fish are thriving and restock them, if necessary. Releasing a few fish and forgetting them for months together does not serve the purpose. Rigid supervision regarding them is necessary.

9. Use of oil

Oil is a precious commodity. Its price has gone up recently and will certainly go up higher. It will also become scarce in course of time. It is one of the items of stores liable to be pilfered. As already stated, oiling should be resorted to only when no other methods of mosquito control are practicable. This is particularly so in drains, ditches, etc., most of which can be kept free of mosquito larvae by proper management.

It should be ensured that the quality of the oil used is adequate. Apart from the frequent shortages of oil which have been experienced from time to time leading to breakdown in mosquito control, there has also been some question about the quality of oil that is being used. Oil is being purchased by the Corporation directly from the suppliers and is also being received as a part of the assistance under the N.M.E.P. It should be ensured that the oil conforms to the specifications laid down by the ISI and the N.M.E.P. Periodical tests regarding the toxicity and spreading power of the oil would have to be carried out to ensure that the oil used is really effective. Often the oil can be made more effective by additives such as creosote and triton x 100 or other emulsifying agents which will increase the toxicity and spreading power. This is a question of an all India nature and needs to be discussed with the State and Central authorities.

Whether oiling should be done either the first thing in the morning or later in the day is an important question. As it is essential that oil should be used to the minimum extent possible and the main recourses has to be taken to control breeding in drains, etc. by source reductions, it is clear that in the first session of the day, the gangmen shonld concentrate on cleaning and channelising the drains by utilizing spades and mumties. Oil should be sprayed later only on such places which cannot be so cleaned or eliminated. This is a matter which should receive urgent consideration and it is suggested that a well designed and controlled study of this method of work should be carried out by the mosquito control section in two or three selected sub zones.

It is noticed that the gangmen going out in the mornings carry one or at the most two supplies of oil to fill the sprayers which they use. The actual time taken to discharge 12–14 litres is hardly 15–18 minutes. Quite often it is even less because the nozzles are too large. For a four hour period of work, this quantity is very small, even taking into consideration the time needed for walking from place to place. The tendency is to exhaust the oil supplies quickly and then saunter about. Adequate quantities of oil have to be made available to the gangmen at the spot for replenishing their supplies. This in fact is being done at present in some instances, but has to become a regular feature.

A good and effective substiture for oil for use in really refractory situations is a pyrethrum based emulsion concentrate. It is only a little more expensive, but can be used in locations which are extremly difficult to deal with by any other method. The quick results obtained by use of pyrethrum concentrates in certain circumstances would justify the cost involved. A pyrethrum emulsion concentrate has indeed been used by the Corporation in 1975 with good results.

It is needless to add that the spraying equipment should be kept perfectly maintained.

10. Chemical larvicides

There are a few synthetic chemical larvicides which can be effectively used for control of *Culex* larvae, such as fenthion, fenitrothrion, abate, etc., but as the widespread use of chemicals is not advisable for various reasons, they can be recommended for use in very special situations only. Paris green in the form of granules or in briquettes can be used in ponds, tanks, quarry pits and even in some large drains with stagnant water. Paris green has been very extensively used in the past for malaria control, but recent experience has shown that it can be used even in its bottom feeding larvae. But it cannot be so efficient either as a good quality oil well applied or synthetic insecticides mentioned above.

11. Work in extended areas

The work to be done in the extended areas of the Corporation under NMEP Urban Malaria Programme has to follow the pattern indicated in the grant made by the central Government. As can be guaged so far, the work runs parallelly to and has to be fully integrated with the work in the city. However, extensive areas of the agriculture tanks and wet cultivation under them pose slightly different problems from those in the city. So far as the mosquito nuisance is concerned, the actions proposed to be taken regarding the tanks and the disposal of the sewage will automatically give relief to the villages in the extended areas also. The drains within the villages should be dealt with just as in the case of the city. Special attention to wells and quarry pits will eliminate the hazzards of malaria caused by *Anopheles stephensi*. Some attention would also have to be given to irrigation channels by use of paris green; because oil cannot be used on them. The whole work in the large rural area included in the extended area needs careful consideration.

In concluding this section on operational methods, it is to reiterated that the highest priority has to be given to source reduction or source elimination by suitable methods, involving both major and minor engineering. There is urgent need to reorientate the entire working system towards this objective. Unless this is done, mosquito nuisance will remain and any breakdown in oil supplies or in the quality of supervision will lead to aggravation of mosquito nuisance.

A simple question which every one has to ask himself on seeing any stagnant water anywhere is "Is this standing water necessary ; if so, how should it be eliminated". Appropriate answers will automatically follow and suitable action has to be immediately taken.

B. Organisational set-up

The present anti-mosquito organisation consists of ;

			Health Officer of the Corporation
Biologist	1		
Entomological Assistant	1		
Insect Collectors	20		
			Anti Mosquito Officer (Medical Officer of Health)
Health Inspectors	....	5	(each in charge of one zone)
Junior Health Inspectors	....	25	(each in charge of one sub-zone)
Head Gangmen	....		(each in charge of one sub-zone)
Gangmen	....	300	751
Additional Gangmen	....	451	

(In addition, there are posts of Clerks, Peons, Drivers, Laboratory Technicians etc.).

The Corporation area has been divided into five zones. The extended area of the Metropolis area of about 145.2 sq. milies is also suitably divided into five sections and attached to the zones to which they are contiguous.

The whole city and the surrounding areas are now covered by the present organisational set–up. There are also a few extra Corporation authorities such as the Railways, Defence Department, large industrial establishments such as HAL, BEL, HMT, etc. which have their own health departments including mosquito control as part of their duties, but the primary responsibility for mosquito control in the city lies with the Corporation. It is understood that there is a Coordinating Committee which meets periodically to discuss and take action on mosquito control problem by different authorities. There seems to be a need to stress again the responsibilities of the different agencies to ensure a really coordinated action. This is all the more necessary now because the field of action of the city anti–mosquito organisation has extended to a wide peripheral belt including most of these industrial units.

The pattern of the present organisation is on the whole satisfactory and needs no radical changes except for a few absolutely essential and urgent requirements and augmentations with a view to increase the operational efficiency of the organization.

1. The role of the Engineering Department

The long term permanent measures which are required are essentially engineering problems and it is necessary that the City Engineering Department and the B.W.S.S.B. take up consideration of the matter at the earliest. It is appreciated that the B.W.S.S.B. engineers are already alive to the major problems of drainage and have certain plans under consideration or execution. However, the matter

needs further and urgent attention keeping the mosquito nuisance problems of the present and the furture also in view. The upkeep of the drains should largely be the responsibility of the engineering department. These would be beyond the normal scope and functions of the anti–mosquito organization which is charged with the existing routine problems and their mitigation. Unless the engineering measures are executed with the utmost despatch, the work of the anti–mosquito section would become a frustrating battle against uncontrollable factors.

Organisation and supervision of mosquito control

The key to success of any repetitive and continuous programme of work such as mosquito control in urban areas is very close and relentless supervision accompanied by assignment of specific responsibilities and a system of checks and cross checks. It cannot be said that they have been at their best, particularly in the levels of Inspectors and Junior Inspectors.

It is not proposed to go into much detail about the work of the Inspectors, but a few essential comments are :

– Some of them have done good work and are experienced, but all of them need training or a reorientation course in modern mosquito control methods ;

– Their responsibilities should be clearly defined and they should be held responsible for any mosquito breeding found in their zones.

– The Junior Health Inspectors should be with the gangs throughout the working day and be directly supervising the work. If there are any problems to be studied or special situations requiring attention, they should be dealt with by the senior inspectors.

– The Senior Health Inspectors should keep a record of all problem places which they are unable to tackle and report them to the Mosquito Officer in writing. At present, there is no dependable system for such reports except oral statements.

– A system of checks and cross checks on the work of the gangs under the inspectors is needed.

– The Senior inspectors should spend at least three hours every day with one or two gangs actually directing the work. They should leave a note in their office every morning so that higher officers visiting their area may locate them. At present it is rarely possible to trace the senior inspectors while on their field duties.

– The senior inspectors should regularly obtain from the entomological staff daily reports of the adult mosquito densities and of actual breeding detected so that prompt corrective action could be taken.

– It is noted that with the increase of the area of operation from 49 to 194 sq. miles as a result of the NMEP assistance, there has been no increase in the number of inspectors. Actually the number of gangmen (field worker) has increased from

300 to 751 without increase in the supervisory staff ; There is need at least for 10 more junior health inspectors to deal with the additional load of work in the extended area. Unsupervised work is totally unreliable.

Gangmen

As stated earlier, they should primarily be used under the guidance of the inspectors to eliminate the breeding places by filling, canalising, etc. There is strong reason for changing the present pattern of their work, viz., 5 days solely for oiling and 1/2 day for miscellaneous duties. As oiling should be the last resort, it is felt that the first few hours of the work every day should be devoted to cleaning and upkeep of the channels and drains and rest of the day devoted to oiling only on such places where breeding cannot be eliminated. It is desirable that in a 7 hour actual working period in a day, the first 4 hours are spent in the source reduction work and the last 3 hours on actual oiling or larviciding.

Generally, the gangmen now carry only oil sprayers. All of them should be provided with spades or mumties also, which they should invariably carry on the field. Other tools like long handled rakes, etc., needed for the large drains should be available for each gang. It is also desirable that at least three gangmen are chosen for each zone exclusively for the work on the treatment of wells aud quarries. As this work will mostly involve the use of gambusia, they should be specially trained for this work. They should be required periodically to visit all the wells and quarry fields within their respective areas. It should be their responsibility to introduce gambusia fish as and when necessary and take other measures to eliminate breeding. All wells should be numbered and a record kept of the visits made and action taken.

No seperate suggestion are made here for the deployment of the 451 additional gangmen mentioned under the NMEP. It is obvious that they have to have a regular programme. As the work in the peripheral aeras has to be fully integrated with the work within the city for mutual benefit, they can be employed both inside and outside the city. This is the best left to the Health Officer to decide.

Organization of the entomological work :

The object of providing entomological staff is to make a concurrent scientific study of the distribution and prevalance of mosquitos from time to time, and not merely for compilation of data for later analysis. The entire work of the Anti Mosquito Section depends upon these studies. Not only will the data they collect help in determining proper control methods, but also it will help for maintaining a periodical watch for the effects of such measures. The data collected should, therefore, be of a high quality which should help the health administration to keep a watch on the progress and control measeares and to take suitable corrective action. The collection of mosquitos and their recording should be such that they sensitively reflect the trends in mosquito densities. Unfortunately, the data collected hitherto were not of a quality or quantity to serve this purpose.

To fulfil these objectives, the entomological work has to be greatly geared up. Till recently, there was only one Entomological Assistant and two Insect Collectors. Since 1975, 18 more Insect Collectors have been provided under the NMEP. The proper utilisation of this staff demands a thorough overhaul of the present methods.

It is not possible to give detailed suggestions in a short note as this, but some of the basic needs are given in a separate note which is attached. To meet these exacting needs, it seems very essential that the number of Entomological Assistant should be increased at least to three.

The three Entomological Assistants should be given duties as follows :

One – attached directly to the Biologist for special studies and for cross check on breeding, etc.

Two – for routine mosquito collections in the entire city, each in charge of a particular section, to supervise the work of 20 Insect Collectors in the field and later to identify, record and tabulate the mosquitos collected by them is a task beyond the capacity of one individual, if the work is done properly.

The Biologist should direct the work of the entomological staff. He should organize the mosquito collection work so that it reflects the day to day position correctly. Only experienced Insect Collectors should be placed in charge of routine mosquito collection for assessment purpose and the rest used for random studies and for checking breeding places for larvae.

Administrative matters

There are a few other matters purely of an administrative nature which need not form a part of this review. They will be dealt with separately.

IV. Summary

The mosquito nuisance in Bangalore City is mainly due to *Culex fatigans* with a subsidiary nuisance due to *Aedes aegypti*. The Health Officers and the members of the anti-mosquito staff are generally well informed of the problems of mosquito breeding in the city, and they have developed methods to remedy some of the problems. By all accounts, there has been much improvement in 1975, as a result of a few effective measures undertaken. This result has to be consolidated and improved upon. Keeping the present as well as the future needs in view, certain modifications and augmentations both in the methods and in the organization are considered necessary.

Broadly speaking, the main conclusions are :

(1) On the basis of the available information drains, nullahs, tanks and cultivation of grass are regarded as constituting the major contributory factors for mosquito nuisance.

(2) Proper and complete disposal of all waste water from the city's water supply and rainfall can only be the final solution. It involves both major and minor engineering works. Permanent measures to put all sewage water underground would have to be undertaken as quickly as possible. The B.W.S.S.B. and the City Engineering Department would have to re-examine the present plans and speed them up, keeping the needs of mosquito control also in view.

(3) The storm water drainage system should be thoroughly overhauled and made independent of the sewage lines. The discharge of domestic waste water into storm water drains should be totally prevented. The Engineering Department has to play an active role in this matter.

(4) Prime emphasis has to be given to source reduction or elimination to be supplemented by other recurrent measures such as use of oil, etc. A special study should be immediately taken up to develop a new working method of the gangs in which cleaning, channelising and otherwise preventing all stagnation of water takes first priority followed by oiling only where nccessary. All gangmen should be provided with spades or mumties in addition to the oil sprayer.

(5) Wet cultivation, particularly grass cultivatoin, should be totally prohibited within the corporation limits. The administrative problems in connection with this needs review and action by the highest authorities.

(6) Tanks within the city should be eliminated except those which would have to be preserved for sentimental, aesthetic, recreational or other utilitarian purposes. Those preserved should be well protected. One of the most important measures needed is that the flow of sewage water either directly or from effluents of the treatment plants should not be allowed into any tank but should be by–passed.

(7) A rational utilisation of the town's sewage water for extensive dry cultivation not only in the present valleys, but also by diversion into the neighbouring valleys, by suitable engineering methods, should be given urgent consideration. Agronomists shonld be consulted on the feasibility of intermittent irrigation under all tanks in the metropolitan area and of the types of crops to be recommended.

(8) Oiling should be used only as suppliment to source reduction. The quality of the oil used needs to be carefully checked and if necessary improved by additives. Pyrethrum larvicides can be used when warranted. Use of chemicals, except in very unusual situations, is not desirable. In addition to the existing spraying pumps. acquisition of a few power sprayers for treating large water surfaces and for use in box drains is considered absolutely essential.

(9) Wells require special organized attention. Either they should be completely eliminated or stocked with gambusia fish. However, the advice of the experts in fisheries may be sought on extensive use of gambusia in the inland waters. Quarry pits can be similarly dealt with.

(10) Other breeding places should be dealt with on merits,

(11) The staff at various level require to be thoroughly trained and whereever necessary given refresher courses. They should be given specific responsibilities so tthat heir works can be assessed.

(12) The supervision of the work has to be greatly improved by better checks and counter checks.

(13) The entomological work needs to be thoroughly geared up so that the data collected are scientifically reliable. The data should be used for concurrent evaluation of the results of the control work.

(14) A separate note on *Aedes aegypti* is attached.

SOME ESSENTIAL NEEDS FOR THE ENTOMOLOGICAL WORK

(1) All the Insect Collectors should be given emoluments attractive to keep the trained and effIcient workers for a few years at least. Frequent loss of trained personnel defeats the very purpose for which they are appointed. They are not to be regarded unskilled labourers and should at least be persons who have read upto SSLC.

(2) All the Insect Collectors need to be trained in the collectoin of mosquitos, by using standard methods. Only fully trained and efficient Insect Collectors should be put on the routine collection work (timed collections). It is suggested that out of 20 Insect Collectors available. 10 very good ones should be given the routine collection work, 6 used for checking breeding places and the remaining 4 placed directly with the Biologist for special studies.

(3) They should be provided with proper and adequate equipment, such as a good flash light, an adequate number of test tubes, suction tubes, cotton, lint, hand bags and a record book (pocket size). They should also be provided with a standard larva dipper. It has been noted that their equipment has been rather deficient for various reasons.

(4) All of them may be provided with a watch or required to possess a watch in good condition. Mosquito collections are made on the basis of time and a watch is absolutely essential.

(5) Each one should possess a bicycle and a rain coat.

(6) Their work should be very closely supervised in the field keeping in mind that they are to collect scientific data on which the entire work is based. The reliabi-

lity of the data has to be assured on the spot. With this purpose. the work done by the Insect Collectors should be asked to make surprise visits and by alternating the Insect Collectors each fortnight.

(7) The record keeping both in the field at the time of collections and their tabulation in the laboratory has to be standardized. Forms for this should be carefully designed. All field record books should be numbered and returned to the office when completely filled up. They should be preserved at least for two years.

(8) While each Insect Collector should have a programme of work for the collection of adult mosquitos in a systematic manner, each should examine a few breeding places at random.

(9) The Anti–Mosquito Officer should be daily informed of the entomological data, preferably by posting up chart prominently kept in his office. Data for each zone as well as for the entire city should be separately plotted. Weekly consolidated data should be put up on a chart in the Health Officer's office.

(10) In addition to hand catching adult mosquitos, other auxilliary methods for determining densities which may not depend on human factors should be explored. The Biologist should carry out investigations in this regard.

(11) All Entomological Assistants should be thoroughly trained in mosquito identification.

AEDES AEGYPTI IN BANGALORE CITY

Aedes aegypti occurs in Bangalore City. It is the well known vector of dengue and chikungunya fevers in the country. Chikungunya has so far not been reported in the city, but dengue infections are now quite common. The Virus Research Unit at the Bangalore Medical College, working under the joint auspices of the Indian Council of Medical Research, the Virus Research Centre, Poona and the Microbiology Department of the Medical College, has made many isolations of dengue viruses both from patients and *Aedes aegypti* mosquitos. This species of mosquito bites by day, unlike the *Culex* and is often extremely troublesome to people because of its painful bite.

Its breeding habits are very well known, i. e., in small man–made containers, such as cement cisterns, overhead tanks, discarded fins, flower vases and pots, etc. which are found in and around houses. But discarded automobile tyres are perhaps the most prolific sources of this mosquito. There are many dumps of such tyers in the city.

Though the species occurs in all parts of the city, it is most prevalent in the highly congested areas. It is prevalent throughout the year, but because of increased availabiity of breeding places, its densities are highest during the monsoon months.

The species is easy to control by simple methods. The most effective one is to enforce emptying and drying all water containers in and around houses once a week. Each householder can help himself and his neighbour. Publicity in this regard is needed as many people in Bangalore are not aware of this mosquito, which they confuse with the general nuisance mosquito. The Anti–mosquito staff had recently traced several mosquito nuisance in some large government offices as due to entirely to this species.

Discarded tyers pose a problem, because they cannot be easily emptied. The anti–mosquito staff may have to keep a watch on all stores or dumps of discarded tyres in the city and treat them with pyrethrum based larvicides, preferably thrown as a fine spray so that it penetrates into all tyres in a stock. The owners of the stocks should be held responsible for keeping the tyres free from larvae. If they fail to do so, they may be dealt with under the appropriate provisions of the public health and Municipal Acts. They would, however, have to be taught how to do it.

Synthetic insecticides can be used. Abate has been found very useful because of its long standing effect and comparative safety. But the use of synthetic chemicals should be avoided as far as possible.

A closely related mosquito species, viv., *Aedes albopictus* also occurs, mainly in the gardens and other areas with trees. It also bites by day time, but it is not much a problem at present. Moreover, little can be done to control them.

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A STUDY ON CORPORATION OF THE CITY OF BANGALORE

M. NAGESWARA RAO *

Introduction

The present study focuses attention on two interdependent aspects of a city government :

(i) Resource mobilisation and allocation patterns and

(ii) Urban local service systems of Bangalore City Corporation since its inception in 1949 to 1981.

While doing so, emphasis is given towards analysing financial aspects vis-a-vis civic service delivery system.

Data Sources

The main sources of data for present analysis are the Administrative Reports of the Bangalore City Corporation. These reports give financial, physical, administrative and service patterns in detail by individual departments of the Corporation. Though data are collected and analysed for 30 years from 1949 to 1981, for the present purpose, the analysis is restricted to seven time points: 1950–52, 1955–57, 1960–62, 1965–67, 1969–71, 1975–77 and 1979–81 (two yearly averages).

Section one attemtpts in brief, the growth, expansion and statutory powers of the Bangalore City Corporation. Section two highlights the growth and composition of resources available to the Corporation. Service expenditure patterns, production and delivery of urban local service systems are analysed in section three. Finally, section four gives an overview of the earlier discussion and makes a few suggestions that may help the City Corporation develop further in view of changing environmental conditions, and ecological imbalances and attitudes of the urban population.

SECTION 1

1.1. Growth and Expansion of Bangalore City Corporation

The Bangalore City Municipality was upgraded to City Corporation with effect from 8th December 1949 by combining the erstwhile Bangalore City Municipal area and Civil Station Municipal Commission. The area of the thus newly formed Corporation was 26.7 square miles (69.12 sq.kms.). The city was divided into 50 divisions which were grouped into 3 ranges. North Range (15 divisions), South Range (16 divisions) and East Range (19 divisions). Each division contained about 1000 to 1500 assessed properties. Later, Central Range was formed with effect from

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October 1960, taking a few divisions from South and East Ranges. In the meantime, the then City Improvement Trust Board (CITB) was forming residential layouts in and around City Corporation upto a belt area of 5 miles (8 kms).

During 1963–64, the limits of the Corporation were extended by including 32 villages and a few CITB residential layouts. This lead to the expansion of Corporation area to 46.5 sq.miles (119.97 sq.kms). Consequently, the boundaries of divisions were revised and increased to 63. The City Corporation Council approved the takeover of about 17 important layouts developed later by CITB in the year 1969. These additions increased the area of the Corporation to 134.42 sq.kms. Consequently, the divisions were reorganised by creating two more zones namely West Zone and North-East Zone.

Again, in view of the fast growth of the city, the Corporation area was further reorganised in July 1979 by dividing the city into two zones, each containing six newly designated ranges.

The population in the corporation area in 1951 was only 7.79 lakhs which increased to 9.06 lakhs in a decade by registering an annual growth rate of 1.63 per cent. However, since then, the growth was phenomenal as, by 1971, the population reached 14.22 lakhs (15.40 lakhs including the CITB layouts) and in 1981 it was 24.83 lakhs. It can also be observed that since 1951, it took about 20 years to double the population but tripled in another 8 years. According to the statistics compiled by the Corporation, the natural increase (births over deaths) from 1971 to 1981 in the corporation area should have been not more than 19.50 lakhs only.

The physical growth of the Corporation may be explained by the rate of development in housing activities. During the year 1960–61 there were 60.06 thousands of assessed buildings. This was doubled in 13 years by 1974 and is expected to be tripled by 1982. Industrial sector has shown enormous growth in large and medium as well as small scale industries within the Corporation area. There were about 2,000 licenced small scale industries in 1956–57 which increased to 6,300 by 1970–71 and to 18,000 by 1979–80.

1.2. Statutory provision and Delegation of powers

The Karnataka Municipal Corporations Act, 1976 (as amended from time to time) is an exhaustive document covering all aspects of Municipal Corporations. In consonance with the general pattern of comprehensive listing, the Act clearly spelt out, *inter-alia*, the financial resources that are allocated and functions and duties assigned to the Corporation. Sections 103 to 148 in chapter X are exclusively devoted to the Taxation powers delegated to the Corporation. This apart, the Corporation is also entrusted with the powers to collect non-tax sources such as fees, charges fines, etc. while discharging certain types of powers to regulate and provide services such as streets, buildings, transport, water supply and drainage, promotion of

public health, safety and convenience, prevention of dangerous diseases, abatement of nuisances etc.

The Corporation, with the prior approval and sanction of the state government and not exceeding the tax rates specified in the Act, can levy any one or more of the following taxes.

(i) A tax on buildings or lands or both within the Corporation area (hereinafter referred to as Property Tax) ;

(ii) A tax on carriages, carts, and animals ;

(iii) An octroi on animals or goods or both (as specified in the Act) brought into the Corporation limits for consumption, use or sale therein (abolished since April 1979) ;

(iv) A toll on vehicles other than motor vehicles entering the Corporation limits ;

(v) A tax on advertisement ;

(vi) A general sanitary cess ;

(vii) A water rate or tax ;

(viii) A tax on profession, trade, callings, etc.

Other than these direct imposts, the Corporation can collect fees in terms of licences such as : Shops and stall licence, tobacco licence, building licence, hotels and restaurant fees, dangerous and offensive trade licences, etc, parking fee for cycles, lorries, taxi stands and bus stands, births and deaths registration fees, fees for burial and burning grounds and other minor charges. There are also certain powers vested with the Corporation to impose fines and penalties for enforcing the local laws such as penalty on belated payment or property tax, road cutting charges, wilfully preventing disdraint, animals impounding etc.

The Corporation is also empowered to make use of the assets (such as lands, buildings and produce there of) and enter into some remunerative enterprises and land development so as to derive financial returns. Some such important sources of income are : rents from markets, slaughter houses, shops and stalls, lease of open spaces, sale of lands and buildings, rents from settlement accounts etc., improvement and/or betterment charges for new residential layouts, swimming pools, dhobi ghats etc.

While these tax and non-tax revenues belong to Corporation's own or autonomous or internal sources, the City Corporation also receives some funds from external sources specifically from state government under certain obligations such as ;

(i) Share in taxes levied by state government such as Entertainment Tax and Surcharge on stamp duty on the Transfer of Immovable property,

(ii) compensation paid by the state to the Corporotion in lieu of motor vehicles tax,

(iii) grants in aid and subsidies and

(iv) loans,

Finally, as a public body, the Corporation maintains extraordinary debt and suspense account, anologous to the higher tier governments. This revenue account comprising of advances, deposits, supense stock, invistments. etc. are to fulfill certain financial, adminstrative and management obligations.

1.3. Functional Demarcation of the Corporation

In a federal set up, urban local bodies are conceived more as agencies of catering civic services direct that as sovereign units in the hirarchy. Precisely because of this conceptual reason, major part of expenditure allocation of local bodies are on maintenance and promotional aspects of service activities only. The expenditures of these subnational governments are hence, visible and verifiable. The benefits derived by the members can be assessed and directly felt with some certaint indeed, the impact is more so in major towns and cities like Bangalore.

Before attempting to analyses revenue and expenditure patterns of the City Corporation, it is all the more relevent to understand the functions and duties delegated and vested with the Corporation which lead us to appraise vis-a-vis its performance.

Here again, a categorical delineation of the functions of municipal governments has been laid down under the State List in the Constitution of India. Hence, the state governments enacted separate legislations to create the local governments in their respective states. The Karnataka Municipal Corporation Act, 1976 thus enumerates all functions and duties relating to the corporations in the state.

Sections 58 and 59 in chapter V of the Act among other things, clearly enumerates the functions of the Corporation consisting of 'Obligatory' and 'Discretionary' functions. The obligatory functions which, the Act says, "shall be incumbent on the Corporation to make reasonable and adequate provision by any means or measures.... for each of the matters" listed thereunder. These functions consist of :

1. marking limits and boundaries of the city,
2. cleaning of public streets, removal of rubbish, maintaining compost yards and plants,
3. collection, removal, treatment and disposal of sewage, construction and maintenance of drainage works, public privies, toilets, urinals etc.,
4. lighting of streets, markets and other places of resorts,
5. maintenance of public monuments, open spaces, etc.,
6. naming and numbering of streets and houses,
7. regulation and abatement of offensive and dangerous trades or practices,

8. maintenance of burial, burning grounds for the disposal of dead,

9. construction, maintenance and regulation of markets, slaughter houses, cattle pounds,

10. maintenance of ambulance service and hearse vans,

11. destruction of birds or animals causing nuisance, etc.,

12. laying out new public streets, footpaths, etc.,

13. maintenance or aiding schools,

14. establishing and maintaining a system of public vaccination,

15. reclamation of unhealthy localities, removal of noxious vegetation and generally the abatement of all nuisances,

16. horticultural and avenue planting activities, public parks, gardens, playgrounds and recreational grounds,

17. construction, maintenance etc. of public streets, bridges, culverts, causeways etc.,

18. removal of obstruction and projections in or upon streets, bridges and other public places,

19. drinking water supply,

20. preventing and checking the spread of dangerous diseases,

21. securing or removal of dangerous buildings and places,

22. residential quarters for pourakarmikas,

23. regulation of lodging houses, rest houses,

24. maintaining sewage systems,

25. taking measures to meet any calamity affecting the public, relief to destitutes and other relief/works etc.,

26. fulfilment of any obligation imposed by or entrusted by state.]

The 'Discretionary' functions which, the Corporation "may in its discretion, provide, either wholly or in part, for all or any of the matters" mentioned thereunder, such as :

(1) **Organization, Maintenance or Management of**

(a) institution for the persons who are infirm, sick, disabled or incurable, etc.,

(b) maternity and child welfare centres,

(c) chemical or bacterial laboratories for the examination or analysis of water, food, durgs etc.,

(d) buildings for corporation officers and servants,

(e) museums, art galleries, botanical zoological exhibitions,

(f) dwelling houses for poor and working classes,

(2) provision of nutritious food and milk to pregnant mothers or infants or school children,

(3) construction of public fountains for human beings and water troughs for animals,

(4) survey of buildings and lands,

(5) entertainment and music programmes for the people,

(6) financial assistance for building purposes and any other measures for the welfare of corporation servants,

(7) contributing to any public fund for relief works,

(8) civic addresses and receptions to the persons of distinction and any other measures likely to promote public safety, health convenience instruction.

The functions thus enumerated are quite comperhensive and as we see subsequently that the Bangalore City Corporation, by and large and over a period of time, attending to all obligatory functions and also managed to discharge most of the discritionary functions too.

Though the above listing of functions appear to be unorganised, the Corporation discharges these functions through various departments established specific to their expertise. Other than Adminstration and Revenue, the Corporation has separate departments for Education, Public Health, Engineering, Markets, Estate, Public Relations and Horticulture.

Again under each department, there are various sub-divisions to look after specific functions, under the decentralisation scheme adopted by the Corporation.

SECTION–II

The growth in 'Total Current Revenue' of the Bangalore City Corprotion over the past 30 years is phenomenal (Table 1). The revenue of the Corporation which was Rs. 79.5 lakhs during 1950-52 rose to Rs. 272.7 lakhs by 1960–62 experiencing with an annual growth rate of 24 percent. Though the revenue increased to Rs. 670.31 lakhs by 1969–71, the rate was only 14 percent during the decade. However in the next decade the revenue increased to Rs. 2904.0 lakhs by 1979–81 thus recording the higher growth rate of 30 per cent. While this part of revenue constitute only through current sources of income, the surpluses carried over to the current periods were also playing an important role. Its share in gross revenue was 8.5 per cent in 1950–52 which increased to 22.7 percent in 1979–81 and occupied an important place in the budgets of the Corporation. Such an increasing phenomen has a serious impact on the expenditures side of the budgets requiring further examination which will be attempted in a later part of this paper.

2.2 Autonomous Sources : Tax and Non Tax Revenue

The Bangalore City Corporation was deriving its major part of revenue from 'Autonomous sources' such as 'Tax' and 'Non-Taxes'. These sources of revenue, constituted 73 percent to 78 percent in the total revenue from 1950 to 1960, but declined to 60 to 68 percent in subsequent years (Table 2). By the year 1979–1981, its share was further declined to 27 percent when octroi was abolished in 1979. In spite of the decline of its share in total, in absolute terms, it continued to grow year after year. In 1950–52, the income from autonomous source was Rs. 58.0 lakhs. It has risen to Rs. 159.3 lakhs by 1960–62 with annual growth rate of 17.5 percent. Further from 1960–62, this income increased to Rs. 429.7 lakhs by registering a growth rate of about 17 percent. The revenue continued to grow until it was brought down to Rs. 77.9 lakhs by an amount equivalent to octroi revenue, which can be observed under Tax Revenue during the year 1979–81.

Tax revenue was contributing 52.6 percent to the total ' autonomous revenue ' in the earlier years and increased to 90.4 percent by 1975–77 but, by 1979–81 it declined to 73.4 per cent again because of the loss of octroi (see Table 3). Consequent to the increasing share of tax revenue, the share of non–tax revenue in total autonomous revenue declined from 47.4 percent in 1950–52 to 39.4 percent in 1960–62, further declined to 9.6 percent in 1975–77 and marginally increased to 26.6 percent in 1979-81. In absolute terms, however, both tax and non-tax revenues continued to grow. The yield from tax revenue in 1950–52 was Rs. 30.5 lakhs, increased to Rs. 570.9 lakhs by 1979-81. Yield from non-tax revenue during 1950–52 was Rs. 27.5 lakhs which increased to Rs.62.8 lakhs by 1960-62 but reduced to Rs. 48.2 lakhs during 1969-71. However, since then, there was substantial growth and by 1979-81, the yield increased to Rs. 207.0 lakhs.

2.3. Autonomous Source: Tax Revenue

Tax Revenue consisting of Octroi, Property Tax, Tax on animals, carts and carraiges, shops etc., Advertisement Tax, Profession Tax, Lighting Tax and Toll on non motorable vehicles (see Table 3). The City Corporation had varied experience in administering these taxes. To start with, Lighting Tax (with water tax) which was collected along with the House Tax was discontinued and merged with the House Tax since April 1965. Earlier, Property Tax was collected on assessed annual rental value, as House Tax, Water Tax and Lighting Tax with separate tax rates but subsequently all these were consolidated to one and made as property tax. Latter, the State Government found that the realisation from profession tax was poor under muncipal administration and hence took over the administration in April 1968. In the meantime, the Corporation introduced Advertisment tax since January 1968. Lastly, Octroi, which was a major sources of own tax revenue was abolished since April 1979.

2.4 Autonomous Sources : Non-Tax Revenue

The revenue from Non–Tax sources include fees, charges, fines, rents and sale proceeds of lands and land produces (see Table 4). These Non–tax levies often con-

fer direct benefits to the payer, and this *quid pro quo* is absent in respect of taxes because the tax revenues are utilised for the overall benefit of the community. The Corporation has greater autonomy with regard to non–tax levies than taxes - since an element of 'price' enters into most of the local services rendered. With regard to 'fees and charges', there would always be a corresponding benefit to the payer, while fines are imposed as a punishment.

2.5 Remunerative Enterprises

Corporation's remunerative enterprieses such as markets, slaughter houses, rents, leases, carts, taxi and bus stands, shopping complexes, stadia, swimming pools and sale of lands and land produces etc. constitute a definite and assured source of income to the City Corporation. While regulating the healthy growth of the city and reducing indiscriminate use of urban land and facilities through land development activities, the corporation also satisfies certain discretionary functions for the benefit of the citizens and their neighbourhood. Revenue from these sources constituted about 29 percent of non–tax revenue during 1950–52 and readily increased to 70 percent by 1979–81 (Table 4).

2.6 Water Supply and Drainage charges

Until the city's water supply and drainage services were transferred to Bangalore Water Supply and Sewerage Board in 1964, the Corporation was getting one half of its non-tax revenues from these two services (Table 4). The expenditure on water supply is met from the revenues secured from water tax and sale of water for consumption. Since this service, is no longer under the control of the corporation, attention is not given to the discussion of this part of revenue at this stage.

2.7 External Sources of Revenue

2.7.1 Revenue Assignments

To achieve uniformity and administrative expediency, some taxes are administered by the state government on behalf of the urban local bodies. Taxes on entertainment and Surcharge on the duty on transfer of immovable properties (in urban areas) are two imposts under reference. The State acts as a collecting agency and the amount thus collected will be transferred after deducting 10 percent as administrative costs.

Entertainment tax is an elastic source of revenue to the local bodies. The share of the corporation in entertainment tax increased from Rs. 2.72 lakhs in 1950-52 to Rs. 22.8 lakhs in 1960-62 and since then tripled in each subsequent decade. (Table 5). It constituted 42 per cent of total external sources of revenue in 1950-52 and increased to more than 74 percent after 1975.

The surcharge on stamp duty is on the instruments of sale, gift, mortgage, exchange and lease in perpetuity of all immovable properties situated within the

limits of the city. Thus the corporation is deriving some revenue which increased from Rs. 1.78 lakhs in 1950–52 to Rs. 26.6 lakhs in 1979–81.

2.7.2 Grants–in–aid and Subsidies

Grant–in–aid has a pivotal role in the democratic and federal government set–up. Grants–in–aid from State Government to local bodies are necessary for, they assure :

1. a sound basis for administration and planning of their activities,
2. balanced growth among local limits by providing a uniform minimum standards of services,
3. as an instrument of leverage to stimulate certain policies and programmes which are desirable in the larger interest of nation and so on.

The purposes for which grants are given to the Corporation differs from time to time depending upon the policies and programmes of the state government. Broadly the purposes for which these grants are given to the corporation are : (1) dearness allowance to the corporation employees, (2) public health, (3) education and (4) other occasional grants and matching subsidies such as slum clearance and slum improvements etc. But by and large, grants are given for meeting expenditures of current nature either in terms of recurring or non-recurring grants. Hence, there may not be any trend over a period of time to influence overall budget of the Corporation. However, Grants-in-aid do influence partly to reduce the burden of service provision by the corporation and initiate to take up certain specific services to the citizens. Thus, the contribution of grants do fluctuate in the total revenues or exetrnal sources of revenues - as sometimes it was only 1.3 percent (in 1960–62) and in another occasion it was 27.4 percent (1969–71) (Table 5).

2.7.3. Loans

While grants come for current purposes, loans play a vital role in asset formation. Usually the corporation is entitled to borrow the loans either from State or financial institutions for the purposes of (1) construction of buildings, (2) acquistion of lands and buildings for development, (3) slum clearance and construction of tenements, (4) road construction and (5) to meet the capital payments such as debt repayment, etc. (earlier, for water supply and drainage purposes also). While in many occasions the state government helps by lending, the corporation had also resorted to at least thrice, to raise a debenture loan in 1935–36, 1961–62 and of late in 1968–69.

Like grants, loan amounts also do not exhibit any trend in the overall growth of the budgets and also do not show definite pattern of its composition. Its share in total external sources of revenue and total revenue were 47 percent and 14 percent respectively in 1960–62 and correspondingly it was only 4 percent and 1.6 percent in 1969–71 (Table 5).

2.7.4. Compensation payments by State Government

The State Government had long ago, confiscated the power of all local bodies to levy taxes on mechanically propelled vehicles but they are compensated by the payment of amounts fixed on the basis of certain calculations. The city corporation, thus earlier was receiving an amount of Rs. 19,601 to till 1957 and since then raised to Rs. 4.57 lakhs as fixed annual payment.

Though not confiscated, octroi was abolished by the state government in 1979 but obliged to compensate the corporation the amount equivalent to the octroi revenue in the form of grant until an alternative source is introduced. Inspite of compensation being paid, the corporation had been handicapped with the loss of regularity in revenue from octroi. One important difficulty was liquidity problem for day to day expenditures and secondly, creation of unproductive establishment of about 550 employees from octroi department.

If octroi compensation is excluded (during the year 1979–81), the compensation payment source of revenue had become a static (since, a fixed amount) and obviously its share in expanding budgets had steadily declined from 31.7 percent in 1950–52 to less than 1 percent in 1979–81 (Table 5).

SECTION–III

3.1. Functional classification and Administration

The functions of the corporation as enumerated earlier are performed by various departments under the overall management and supervision of Commissioner, Deputy Commissioner and their subordinate officers. Thus, the corporation has departments to look after, as briefly mentioned earlier, the following functions.

Health, Education, Roads, Buildings and Engineering, Horticulture, Markets and Revenue Collection etc. and most of their activities are decentralised through range, division and sub-division offices. Again, many departments have various sections and sub units for specific functions such as Electrical works, Roads, conservancy, sanitation, mosquito control, estate, building licence, town planning, workshop, stores, etc.

Consequent to the above functional division, the expenditure can also be broadly classified as present in Table 6. It can be seen from this table that public health (including public amenities) occupies the higher position with nearly one fourth of the total expenditure. This is closely followed by communication and engineering works and water supply. It is interesting to observe that during the period of 30 years, none of the functional classifications have changed their respective positions significantly except periodical fluctuations.

3.2 Public health

Public healh–as is referred to in the urban local public sector constitute various subgroups such as medical relief, preventive medicine, environmental and industrial sanitation, conservancy, births and deaths, food adulteration, etc. Again, each subgroup comprising of related items specified under obligationary functions in the Act. A glance through these functions reveals that most of the functions in one way or other fall under the head 'Public Health'. Hence the commitment of the corporation in terms of budgetary allocation reflects that public health services are always dominating all other service categories. As can be seen from Table 6 the expenditure proportion of public health is highest among all expenditure shares. On an average, its share in the total budget is about 25 percent. Though, like many expenditure components, its share remained almost stationary it exhibited mainfold increase from Rs. 20.8 lakhs in 1950–52 to Rs. 187.8 lakhs in 1969–71 and further to Rs. 558.8 lakhs in 1979–81. An important observation necessitates in this regard. As this service is basically welfare oriented, much of its outlays are consumed by salaries, materials, and other establishment charges of current nature which constitute more than 60 percent of public health expenditure.

As mentioned above, the public health expenditure consists of various items (Table 7) of which conservancy and sanitation is predominant by claiming a major share of more than 55 percent in total health expenditure. The second major component, is Births and Deaths followed by preventive medicine and they constitute on an average, 15 percent and 10 percent respectively. Expenditure share of medical relief was higher during 1950s, but declined in latter years from 11.0 percent to 5.4 percent by 1979–81.

3.2.1 Medical Relief : (a) Dispensaries

While state government and private hospitals give treatment to various diseases, the Corporation is mainly concerned with the treatment of infectious diseases, preventive measures and medical relief to the general public. The Corporation maintains allopathic, ayurvedic and unani dispensaries in the city to render medical relief services to the citizens. In 1960–61, the Corporation had one allopathic, one ayurvedic and one unani dispensaries for medical treatments of various diseases. The allopathic dispensaries were gradually increased to 12 by 1980–81. The out–patients treated in ayurvedic and unani dispensaries numbered on an average about 100 per day in each, the allopathic dispensaries located at city corporation premises, Jayanagar, Neelasandra, Adugodi and Cox Town areas appear to be attracting numer of patients for treatment. In addition to these departmental dispensaries, the Corporation also pays grants–in–aid to, about 24 local fund dispensaries and Isolation Hospital run by Government, St. Maratha's Hospital and to other private institutions.

(b) Ambulance and Hearse Van Services

To enable the public for shifting the patients to the hospitals during emergency hours and for conveying dead bodies to burial grounds, the Corporation provides ambulance and Hearse Van Services to the public round the clock on nominal charges. The Corporation had only 3 ambulance vans and one Hearse van till 1967 and as the response from the public particularly from poorer sections was good, the Corporation increased the fleet to 8 each in another ten years duration.

(c) Dog and monkey nuisance

To reduce stray dogs and monkey nuisance in city area, the Corporation maintains two animal catching squads to catch such animals, impound them at Koramangala Dog Pound and dispose them at 72 hours by electrocution.

Expenditure under medical relief sub head increased from 3.2 lakhs (15.5 percent of total public health expenditure) in 1950-52 to Rs. 29.9 lakhs (5.4 percent) in 1979-81 (Table 8). The share of dispensaries was fluctuating between 10 to 30 percent, capital formation in terms of new dispensaries, purchase of ambulances and hearse vans etc. increased the capital account share from as low as 1 percent in 1961 to 44 percent in 1980. It can also be observed that the grants and contributions to other hospitals have considerably declined from 55 percent in 1965-67 to 4.4 percent in 1979-81 as these amounts remained constant over the years.

3.2.2 Preventive Medicine

Controlling the communicable diseases such as plague, cholera, small pox, malaria, typhoid, deptheria, tetanus, chicken pox, hydrophobia, measles, mumps etc. is undertaken by the Corporation within its jurisdiction. Preventive measures such as :

1. Inoculations for cholera, typhoid etc.
2. Vaccination and revaccination for small pox etc.
3. Cynofumigation of houses and rat burrows to prevent plague,
4. DPT injection of 3 doses for Deptheria and Tetanus,
5. Prophylactic treatment for dog bite cases and destroying stray dog etc. are the routine operations conducted by the Corporation through Corporation dispensaries, sub-health centres, maternity homes and child welfare centres. More attention is however given to small pox, malaria, and T. B. Control Programmes with the guidance and aid from State and Central governments.

Urban T. B. Control Programme was started in 1960 in the Corporation Area. By 1965, with gradual expansion, T. B. Control work was extended to all the public health dispensaries making all of them as referal-cum-treatment centres. Introduction of National Small Pox and Malaria Eradication Programmes stimulated the

operation of eradicating epidemic and endemic diseases by the Corporation. 36 vaccinators and 8 supervisors of Small Pox Eradication Programme are working and supervising the operation.

3.2.3. Mosquito Control/Malaria Eradication Programme

Like any other city or town, Bangalore too is confronted with the mosquito nuisance since atleast four decades. Mosquito control programmes thus have become a part of the public health activities of the Corporation. Until 1963, controlling mosquito nuisance was done on a routine basis with the following activities.

1. cleaning the drains,
2. removal of rank vegetation,
3. larvicidal spraying with Hixidole, malarial oil, turkey red soil etc.,
4. introducing larvicidal fish (Gambosis) in wells, cisterns, quarries, cess pools etc., and
5. collecting adult mosquitos.

Later, with the introduction of National Malaria Eradication Programmes (NMEP, 1963), the mosquito control activities were intensified in the Corporation with the financial assistance from State and Central governments.

During this period, extension of city area by including some villages and also newly added slums resulted in increased burden of mosquito control programmes of the corporation. The long term mosquito control programmes undertaken till 1962 were :

(1) construction of box drains in Gandhinagar, Palace Guttahalli, Dr. T. C. M. Royan Road ;

(2) drainage works and new drain constructions in pipe line area, Sidhant Block, Malleswaram, Swimming Pool, N. R. Colony, Pension Mohalla ;

(3) covering box drains in Cubbonpet, extending box drain leading to Agrahara Tank, covering main drain in Silver Jubilee Park Road, continuing the main drain leading to Koramangala tank ;

(4) breaching the Binny Mill Tank, deweeding in Mud Tank, Kempambhudi Tank, etc.

However, certain permanent measures were also taken up such as :

(1) stopping quarrying at Sarakki, Karithimmanahalli, Byrasandra, Muni-reddypalya, etc.,

(2) water management of Lalbagh Tank ;

(3) preventing grass growing in Dharmambudhi and Kempambhudhi tanks.

The staffing pattern was only nominal, consisting of one Assistant Medical Officer, 6 Junior Health Inspectors, 12 Head Gangmen and 86 Gangmen. The estimated mosquito density per man hour was ranging between 2 to 4 during this period.

As per the new programme of 1963, entire Corporation area as well as one mile belt area outside the boundaries were taken into mosquito control operation. This area was divided into five operational units, viz., (1) Malleswaram, (2) Vrushabhavathi, (3) Basavanagudi, (4) Koramangala and (5) Chellaghatta.

Each operational unit is divided into five sub-units ; namely, A, B, C....Y (total 25 sub units), and each sub unit is further divided into five day blocks (Monday to Friday and Saturday is reserved for Minor engineering works). Each day block is again divided into ten sub blocks. Consequently, the staff patterns also undergone changes. A separate Section was started with the incharge of one Medical Officer assisted by 5 Unit Officers, 25 Head Gangmen, and 300 Gangmen. Each sub block is attended by a Gangmen. Two Gangmen will attend to minor engineering works, help to transport oil, etc. Necessary equipmeut was purchased and supplied to the units. Appropriate training was given to the unit officers and sub inspectors by Department of Public Health. 255 maps were prepared for each unit and 55 villages were included for larvicidal work. The work was so arranged that the entire Corporation and one mile belt area is covered for oiling operation once in a week.

Apart from the routine operational works mentioned earlier, the programme was extended to

(1) filling the insanitary pits, quarries and brick kilns,
(2) clearing the hyacinth weeds from the tanks,
(3) formation of new drains,
(4) stopping the quarrying in and around the city,
(5) clearing the drains of silt and marginal vegetation,
(6) prevention of the grass cultivation within and outside the corporation,
(7) prevention of unauthorised tapping of sewerage water for vegetable and grass cultivation, etc.

Supplementing the above operation, Urban Malaria Control Programme under NMEP was started during 1975-76 adding further to the existing staff. This facilitated the Corporation to extend further the mosquito control operation. With the assistance of these staff, deweeding, breaching and wherever possible converting the tanks suitable for civic amenities etc. were taken up rigorously.

The expenditure pattern on mosquito control had changed accordingly since 1962-63 as can be observed from Table 9. It was only Rs. 1.32 lakhs in 1960–62 which was increased to Rs. 8.62 lakhs in 1969–71 and further to Rs. 42.00 lakhs in

1978–81. Until 1962 its share was about 40 percent of the expenditure under preventive medicine, but steadily increased to 78 percent by 1978–81. This trend clearly indicates the importance given to the problem of mosquito eradication by the Corporation.

However, it is paradoxical to observe that inspite of all these efforts, the per man hour mosquito density increased from 4 in early sixties to 21.9 in 1980–81, that is, in a period of about 20 years.

3.2.4. Births and Deaths

Registration of births and deaths, compiling and maintaining vital statistics of the city area is the duty of the local bodies in accordance with the central and state (Karnataka) Registration of Births and Deaths Act. A section within the Health Department is entrusted with this task.

The Corporation maintains Maternity homes for attending to normal labour (delivery) cases. The mothers and new born babies are kept for eleven days and during this period nutritious food is served free of charge. There were ten maternity homes with 233 beds during 1960–61 and the average attendance was to its fullest capacity. Eight maternity homes were newly added by 1970–71, thus increasing the bed strength to 492, and by 1980–81, there were 29 maternity homes with a bed strength of 710. The number of deliveries conducted were 8380 in 1960–61, 16,506 in 1971–72 and 23,273 in 1980–81.

Apart from conducting deliveries, antinatal clinics, post natal clinics, Immunisation clinics, well baby clinics, paediatric clinics and family planning clinics are conducted once or twice in a week at each maternity home. Primary vaccination and revaccination are given to the children, protected against diptheria, whooping cough, tetanus and given triple antigens.

Maternal and child welfare centres are established in various parts of the city by the Corporation. There are altogether 28 such centres where in again, antinatal clinics, well baby clinics, post natal clinics are conducted once in a week. Domiciallary services by midwives and lady health visitors attend to the calls for deliveries, give health talks, antinatal first and revisits, post natal visits etc.

A special nutrition programme for children and pregnant women in urban slums was introduced by the Corporation from 1971 with the financial assistance from state government. Free milk and bread were supplied through 125 centres to children below 3 years age and expectant and nursing mothers 5 or 6 days a week. About 75,000 children and pregnant women are benefitting by this programme.

6 creches are maintained to look after children below the age of 5 years of working mothers from 8 a.m. to 5 p.m. every day. Employees of the corporation, particularly pourakarmikas (sweepers) are benefitting from this scheme.

Family planning activities gained momentum after establishing a city Family Planning Bureau and the Urban Family Planning Centres by the Corporation in 1966. Subsequently, the India Population project and some voluntary organisations such as Family Planning Association of India, Red Cross Society, Lions Club etc. started Family Welfare centres in different maternity homes and child welfare centres. At present there are 31 family welfare centres covering major part of the population in Bangalore city.

The expenditure share on these activities under the sub head 'births and deaths' constitutes about 15 percent of the total public health expenditure. Though its share was fluctuating between 10 percent to 18 percent, there is substantial increase in actual allocation under this head. From Rs. 2.13 lakhs in 1950–52, the expenditure on births and deaths increased to 8.91 lakhs in 1960–62, to Rs. 22.96 lakhs in 1969–71 and to Rs. 69.01 lakhs in 1979–81 (Table 10). However, establishment and salaries alone were consuming about 40 percent of the expenditure. During the period between 1960 and 1977, the capital works like construction of new maternity homes, child welfare centres etc. took substantial investments (20 to 40 percent) and latter however reduced to about 4 percent only.

3.2.5. Food, Environment and Industrial Sanitation

One of the main duties of the Corporation is to keep the city and its environments clean and tidy. The Health Department is incharge of such environmental, industrial and food sanitation operations in the city.

(a) Food sanitation

Under the provisions of the Prevention of Food Adulteration Act 1954, the Corporation is entrusted with the duties of inspecting food trades and make necessary arrangments to launch prosecutions against the accused of adulteration or misbranding. Six food inspectors collect samples of various food commodities such as milk and milk products, oils, coffee powder, tea, gram flours, spices, coloured sweets and condiments etc. and sent to the public analyst for examinatton. It is observed that majority of samples collected belong to milk and milk products and found adulterated. Though the functional character is only regulation, the Corporation appears to be not discharging the provisions of the Food Adulteration Act satisfactorily – due mainly to insufficient staff of this section.

While dealing with the food sanitation, the Corporation encounters with different attitudes of the street trading fraternity and road side food vendors whose utter indifference causes a great hurdle to the authorities. Even though a constant pressure was maintained in a limited way, it is leading only to temporary success without long lasting solutions.

(B) Environmental sanitation

The most important duty of the Health Department is to provide good sanitation in the city. To do so, the work was divided into two part : (1) sweeping and

collecting the rubbish and garbage and (2) removing of rubbish/garbage from dustbins and transporting to the final disposal points. For overall supervision of the sanitation, the entire city of 63 divisions was divided into 6 ranges and 103 sub-divisions, each under the control of One Junior Health Inspector. The work of about 50 pourakarmikas and sanitary Daffedars in each sub-division were supervised by the Junior Health Inspectors in respect of sweeping and collecting the rubbish. To carry the rubbish to the dumping yards, lorry transportation was provided to the divisions. The staff engaged in dumping yards looked after the sanitation of the dumping yards. Usually, the rubbish is partly dumped into big pits and quarries in the city limits in order to fill them up and reclaim the land for civic amenities. About 1000 tonnes of rubbish were collected every day in about 80 trucks.

Market sanitation and burial ground sanitation were looked after by the concerned Range Medical Officers. As the departmental work was not sufficient, private contracts were given to look after cleaning of S. K. R. Market, Russel Market and some divisions in the city.

Health licences for running trade in corporation area were also issued by the Health Department. The senior Health Inspectors of each circle inspect hotels, restaurants, bakeries, aerated water factories, markets etc. to look after the hygienic standard of the food items sold. In 1960–61, 1373 food trade licences were issued of which 857 were hotels, restaurants etc. By 1970–71, the food trades increased to 2043 (of which 1300 were hotels and restaurants) and by 1980, the licences issued were 3974 (of which 2500 were hotels and restaurants).

(C) Industrial sanitation

Regulating the sanitary condition of power trades (small scale industries) and dangerous and offensive trades within the corporation area and issuing licences for new entries are the activities of the corporation. The locational factors such as residential, commercial and revenue pockets of the city area are examined and when fully satisfied with the environmental sanitation such as water supply, drainage and congenial atmosphere for labour, the corporation issues a licence. The number of power trades such as small scale industries, flour mills, smithy, foundaries, laundries, etc. were 3218 in 1961 increased to 8200 in 1971 and further increased to 19,038 in 1981. Similarly, dangerous, and offensive trade licences such as fuel and charcoal depots, shaving saloons, safety matches, timber yards etc. increased from about 3100 in 1961 to 5700 in 1971 and were decreased to 2733 as some of the trades were reclassified under power trades.

Conservancy and sanitation occupies a dominant role in public health expenditure. Its share always exceeded more than one half of the total public health expenditures and more than two thirds of it is meant for salaries alone. Expenditure on conservancy and sanitation increased from Rs. 11.9 lakhs in 1950–52 to Rs. 26.06 lakhs in 1960–62, since then almost doubled for every 5 years and reached

Rs. 342.68 lakhs by 1979–81 (Table 11). Capital formation is obviously very meagre except the invessments made on slum clearance and rehabilitation works during the period fron 1956 till the formation of Slum Clearance Board.

3.2.6 Public Amenities

Amenities such as parks, gardens, playgrounds, swimming pools, bathing and dhobi ghats, amusement like music, dance and entertainment, libraries and reading rooms etc. are some important services provided by Corporation to its citizens. These activities help improving the general health conditions of the public and hence it has become a component of Public Health Department.

3.2.7 Horticulture

Unlike many cities, Bangalore Corporation has the credit of acclaiming the city as a prestigious and beautiful garden city in the country. The existing widespread of salubrious climate and agro-economic conditions and also rich potentialities of soil help in maintaining a wide range of ornamental and avenue planting patterns by the Corporation. This has also favoured the Corporation committed to help improving general living standards and aesthetic values of the people.

Horticultural activity has been present long before the inception of the Corporation and the city was spotted with beautiful parks and gardens. Corporation took keen interest in exploiting the favourable conditions in expansion of already existing horticultural facilities. During 1955–56, there were atleast 30 parks and gardens of different sizes (other than Lalbagh and Cubbon Park) important among them were Silver Jubilee Park, Municipal Garden, Coles Park, Banappa Park, Richmond Park, Chicklalbagh, etc. Apart from this, the Corporation also maintained about 50 traffic circles, ovals, corners, hillock gardens etc., with ornamental plants and lawns. Subsequently, by 1980–81, the Corporation succeeded increasing these activities and raised the parks and gardens to more than 210 including beulevards, Rose gardens, circle gardens etc. Every year, not less than 5000 avenue trees were planted throughout the city with appropriate tree guards for protection.

3.2.8 Play grounds, Swimming pools, amusement, libraries, and reading rooms

For orderly growth of the city and better neighbourhood, the Corporation maintains number of open spaces, playgrounds and sports stadia in different localities of the city. Play ground equipments for children such as swings, ladders, bars, sliding slants etc., and game equipments and ground materials like basket ball polls and gaurds, football courts, kho kho courts are also provided to encourage sports activities for interested players. There are six swimming pools and a boating facility at Ulsoor lake, 6 dhobi ghats, a number of libraries and reading rooms, community halls, open air theatres and platforms for music and entertainment and other public functions facilitate the city dwellers relax and entertain with these civic amenities.

During the past 30 years, the expenditure on public amenities has increased substantially (Table 12). A major part of the expenditure was on horticultural activities. New formations and capital works on public amenities constituted about 45 per cent while the rest was on salaries and establishment.

3.3 Roads and Remunerative Enterprises

Construction, maintenance and development of road net work is one of the basic functions of the city corporation. The expenditures on roads and communication is considered to be a good investment because it brings people together, relieves congestion, provides smooth vehicular traffic and assists commercial and economic activity. Communication system itself is an indicator of the performance of the local bodies. Next to public health, communication system occupies an important role in the budgets of the Corporation. The city is experiencing a continuous increase in vehicular traffic with the inclusion of layouts, extensions and villages, thus inviting heavy capital investments on road formations and maintenance. A number of major improvements such as widening of main roads and shelcreating of important roads are also taken up in addition to those contemplated under the Better Roads Scheme. While the investment requirements on roads alone was heavy, bridges, culverts, causeways and pedestrian subways and overbridges on one hand and formation and improvements to traffic islands, circles, footpaths and road side drains on the other hand consume substantial funds. Added to this, 32 newly added villages (in 1964–65), and a number of CITB and latter BDA layouts included in Corporation aerea increased the commitments on roads by the Corporation. Expansion due to the above additions did not add much to the revenue but enhanced the financial burden of the Corporation.

Next to public health, roads and communication expenditures occupy a higher position in the total budget of the corporation, if water supply is excluded. This constituted about 14 percent of the total expenditure in 1950-52 and since then scaled to 27.8 percent by the year 1969-71 but declined to 19.1 percent by 1975-77 and further reduced to 16.7 percent by the year 1979-81. However, in absolute terms, there is a phenominal increase ever since the Corporation was established. Total expenditure on roads increased from Rs. 10.7 lakhs in 1950–52 to Rs. 39.4 lakhs in 1960–62, Rs. 199.2 lakhs in 1969–71 and Rs. 390.8 lakhs by 1979–81. That is, they almost tripled for every decade (Table 13). New formations of roads and bridges consume more than one half to two thirds of the total expenditures on roads particularly since 1965–67. On the other hand, the component of maintenance and repairs had steadily declined from 30.3 percent in 1950–52 to 3.8 percent in 1965–67 and increased marginally to 7.8 percent in 1979–81. This is attributable to the increasing concentration of capital works in the rural components which were added in the corporation area.

3.4. Remunerative Enterprises

Remunerative enterprises constitute a key sector in the economics of local public sector. Markets, slaughter houses, animal pounds, cart and bus stands, canteens,

shopping complexes, guest houses, residential houses for employees, land development by forming lay-outs etc. form some such local level commercial enterprises. They not only help orderly growth and increase the level of standards in the neighbourhood, but also generate continuous and assured revenus to the Corporation. There are three major markets - SKR Market, Russel Market and Malleswaram Market which are famous in the city and providing more than 2500 stalls. Minor markets in different localities of the city also cater to the needs of the people and they yield some revenue to the Corporation. With the expansion of the city, corporation also took the work of constructing small markets. In 1960–61, there were only 27 such small markets and increased to 49 by 1980–81.

Since long, the corporation has been comtemplating to go for a large shopping complex and the outcome during the last 20 years was appreciable indeed. The Corporation today has two prestigious shopping complex-*cum*-cinema theatres at Jayanagar and M. G. Road and atleast four such shopping complexes are under construction in different extensions and layouts.

There are three slaughter houses in the city of which one is for beef. Slaughtering of animals is conducted after inspection by Veterinary Inspectors in charge of slaughter houses. The meat of the animals is also certified by Meat Inspectors as fit for human consumption- The number of animals brought for slaughtering is steadily increasing. However recently with the recommendation of the State Government, all the slaughter houses were handed over to Animal Food Corporation during the year 1975.

Corporation houses for residential purposes, leasing of lands, timber yards, etc. consitute another form of remunerative enterprising. City Corporation had constructed houses for its own employees as well as under settlement accounts in various parts of the city. Notable among them are houses in Kumara Park, Labour Colony, Multistoreyed buildings at Kalasipalyam, Jayanagar, Ghavipuram and Sonnenahalli, Austin Town, Murphy Town, Williams Town, etc.

Even though the Corporation is earning substantial income from all the remunerative enterprises, corresponding expenditures are made for maintenance and repairs and also new capital investments. The total revenue from this souree was higher than the expenditure till 1965–67, but this was reversed since then, particularly by investing on new enterprises such as expansion, additions and new constructions of shopping complexes, quarters and tourist homes. However, the share of expenditure on remunerative enterprises and land development remained stationary – around 3 percent of the total expenditure. Again, the share of capital works in this expenditure category increased from 46.4 percent in 1950–52 to 75.7 percent in 1979–81 (Table 13).

3.5 Street illumination

Street and public place illumination is one of the basic function of the local bodies. Generation and distribution of electricity are the responsibilities of state

government, hence local bodies do not incur capital investments on these items but only meeting the electricity consumption charges due to street illumination within the local jurisdiction and maintenance, costs of repairs and replacements are the responsibilities of local bodies.

Bangalore city was electrified in 1905 and the then town council provided a meagre 310 street lights of 15 watts and 200 numbers of 25 watts incandescent lamps. Subsequently in 1908, the cantonment area was electrified and about 250 street lights were installed. Until 1925, there was not considerable inerease in street lights. During 1927–28, a number of ornamental type domelights were installed in places like Cubbon Park, Lalbagh and some important roads. In 1930-31, a notable contribution of the then Dewan of Mysore, Sir Mirza Ismail who took keen interest in making the city beautiful was the gigantic five way clusters which are still existing in front of the City Market, Russel Market and Hudson Circle. A real but remarkable growth in street illumination took place since then to the present state with nearly half a million lighting points spread over the Corporation area.

Since the inception of the Corporation, street lighting functions in Bangalore City are shared between State Electricity Board and the Corporation. Until 1960-61 the Corporation was paying electricity consumption charges and reimbursing the costs of replacements and new fittings to electricity board as the Board was entrusted with the work. However, later in 1970-71, with the recommendation of the state government, a street light division was created under the adiministrative control of the Elertricity Board which help the corporation to improve the street light system in planned way and also for speedy execution of street light works. Simultaneously, the corporation also created a sub division temporarily in the Corporation Engineering Department exclusively for electrical works of the Corporation in view of the fast expansion of the city. Though it was postulated that the electricity board will transfer its street light division to the corporation after one or two years, such measure was not attempted since then for various reasons.

The expenditures on street lighting kept on increasing from Rs. 1.7 lakhs in 1950-52 to Rs. 8.4 lakhs in 1960-62 to Rs. 17.0 lakhs in 1969-71 and Rs. 93.00 lakhs in 1979-81 (Table 14). However, its share in total expenditure did not change during these years which remained on an average at 3 to 3.5 percent (Table 6). Within the total expenditure on lighting, a major part of it goes to the electricity consumption charges, followed by maintenance and replacement costs (Table 14).

3.6. Water Supply and Drainage

Although drinking water supply and drainage services are the basic functions of local bodies, these were managed by a specialised agency in Bangalore City. Till the formation of the Bangalore water Supply and Sewerage Board (1964), the provision of this service had been made by the Corporation itself and later, these were completely transferred to the Board. However, the Corporation still spends on these

services within the limits of powers conferred by the Act. For example, payment of water charges on public taps, water charges towards free allowance to the domestic consumers, water charges for corporation buildings, parks, gardens, maternity homes, schools, providing and maintaining street taps, etc. are some of the responsibilities undertaken by the Corporation. Such diversified activities and responsibilities are actually replaced the earlier original water supply service expenditures and they were steadily increased since 1969-71 as can be seen from the Table 14. Similarly, construction of surface and storm water drains, improvements to tanks are some drainage works undertaken by the Corporation. The share of expenditure on water supply and drainage in total expenditure constituted about 16 percent during recent years while it was about 25 percent in the earlier years.

3.7. Education

Provision of elementary and secondary education is the responsibility of the Corporation within its jurisdiction. In addition to imparting academic education, the Corporation also provides vocational training in carpentry, spinning and weaving, tailoring, drawing, music, horticulture etc.

The growth partern in imparting the education by the Corporation has interesting phenomenon. During the year 1960–61, the Corporation was running only 7 high schools (5 for boys and 2 for girls), one primary school and one nursery school. Within a period of 10 years, the number of schools increased to 22 high schools (11 each for boys and girls), five primary schools (four for boys and one for girls), and 35 nursery schools increasing the student strength from about 9,000 in 1960–61 to more than 15,000 by 1971–72. By 1980–81, the Corporation established three composite junior colleges and further expanded the nursery schools to 58, though there was no new additions in high school and primary schools. Majority of the enrolment in these public educational institutions is from middle class, eeonomically weaker sections and SC/ST categories of citizens.

Special facilities like providing uniforms, books and examination stationary for SC/ST students, nutrition programmes such as distribution of milk and bread every day for children in aqout 35 nursery schools located in slum areas, mid-day meal scheme in selected primary schools, scholarships of deserving and meritorious students, teachers, seminars, physical education programmes, grants to other educational institutions and maintaining a good number of playgrounds with play equipments for children are some of the activities of the department.

The expenditure component of the education service constitute only about 2.6 percent to 5.4 percent of the total expenditure of the corporation. In absolute terms, however, it increased steadly from Rs. 2.17 lakhs in 1950–52 to Rs. 97.4 lakhs in 1979–81. The major part of the increases are accounted for establishment (Table 15) which constitutes more than 70 percent of the total expenditure on education,

Between 1960 and 1975, capital works such as construction of school buildings took about 20 percent, but this component in latter years is compensated by maintenance expenditures.

3.8. Overall Budgetary position

After examining the income and expenditure patterns, it is pertinent to review overall budgetary performance of the Corporation. In doing so, a distinction should be made between State and Urban governments budgets. In the case of former, funds are raised through taxation to fulfil the predetermined budget allocations where as, in the latter, expenditures are made depending upon the funds realised. This lead to the urban local governments to balance the budgets - that is, expenditures equal to income with a statutory obligation to leave a minimum surplus equivalent to three months establishment charges. Hence, in this case, deficit budget does not arise. Viewing in this direction, it can be observed from Table 16 that the City Corporation always had substantial budget surpluses (closing balance) throughout the period. In the first 8 years, the surpluses were about 10 to 12 percent of the total revenue, but since then, it increased to a staggering level of 38 percent which is not a healthy trend in the realm of commitments of the city government like Bangalore Corporation. The trend also contradicts the claims of city government for further financial resources while the available revenues are not utilised properly. It is estimated that the closing balances were 7 to 10 times higher than the statutory requirements (as calculated in col. 5, Table 16).

SECTION IV

OVERVIEW AND A FEW SUGGESTIONS

In view of phenomenal growth of the city a periodical review of the finances and functions of the Corporation is warranted which has an important role in the framework of national development in general and at local level in particular. Not withstanding the centralisation trends such as encroachment of fiscal and functional powers of urban local governments by the higher tier government, it should be well acknowledged from the earlier analytical observations that the Bangalore City Corporation had by and large faired satisfactorily in mobilising the revenue – partly by its managerial efficiency but prodominantly due to the in built flexibility and boyancy of tax and non tax bases over this period of time.

There is also enough evidence from the expenditure and service delivery patterns to state that the Bangalore City Corporation is one of the best corporations in India with all the limitations and constraints that are inflicting the basic functions of the Corporation. However, in relation to the available resources, the service delivery system calls for proper explanation on the following grounds.

(i) There was no expansion, growth and sophistication in urban service levels commensurate with the growth of revenues ;

(ii) Unconvincing allocations of expenditure components such as payment of free allowance water supply charges of the domestic consumers, lower rate of property tax but higher emphasis on civic amenities in the newly added rural components ;

(iii) Unresolved authority and commitments between BDA, Slum Clearance/Improvement Board and the Corporation on the newly formed layouts and slums and finally ;

(iv) Irrational budgeting and budget manoevers leading to extremely high proportions of budget surpluses specifically since 1975.

While individual services were expanded drastically as observed from each expenditure component, the age old traditional pattern of service expenditure composition has remained unchanged over a period of 30 years. The Corporation appears to be not enthusiastic to breakaway from such a tradition either to venture additional functions or to adopt technological changes in service delivery systems. Exceptions can however be identified in the cases of horticulture, mosquito control, land development and remunerative enterprises. Branches like education, hospitals and dispensaries require qualitative improvements to compete with the private sector atleast in a limited way. A passing reference can be made to the slackening capital works particularly on roads, buildings and street illumination activities since 1975-77 from which period the supersession of the Corporation Council coincided.

A few but important suggestions follow from the above observations :

(i) The Corporation should never go for territorial expansion by augmenting the rural components around the city as Corporation had not yet recovered from the bitter experience of 1964. It should only take control of residential layouts fully developed and satisfying all the statutory requirements from BDA.

(ii) Within the framework of existing provisions of the Corporation Act, there are ample opportunities to spread the network of non-tax revenue and remunerative enterprises sources by the Corporation which not only yield substanital revenue to the exchequer but also help regulating and containing the unhealthy and haphazard growth of informal sector, illegal practices of commercial and industrial sector.

(iii) There is an urgent need to introduce financial and physical planning system in the Corporation. Unlike the present system of yearly budgeting with arbitrary and ad-hoc planning procedures, a kind of, to start with, three

yearly rolling plan with predetermined physical targets could be attempted. With the experience gained, this can be extended to 5 years terms coinciding with the State Five Year Plans.

(iv) The creation of special agencies for special functions such as BWS&SB, BDA, Slum Clearance Board, Town Planning Department and utility agencies like Electricity Board, BTS, P&T Departments are basically lacking coordination among themselves and particularly with the City Corporation. A clear cut wayout should be formulated to help removing the hurdles as early as possible. In any case, the Corporation should have a dominant role amongst all the these agencies as this is the popular body democratically elected under the principles of self government and very nearer to the pulse of the people.

(v) It is high time that the Corporation should look forward to, as warranted by the fast changing urbanites' attitudes and technological innovations, the sophistication, and modernisation in the service delivery systems and thrive hard to bring qualitative improvements in public health services such as conservancy and sanitation, hospitals and dispensaries, maternity and child health centres, mosquito and parthenium eradication etc.

(vi) The time has come, for the Corporation to publish and bring out periodi cally, a type of 'Civic Journal' which should contain all the activities of the Corporation, basic statistics, important annoucements, popular articles educating and enhancing the civic consciousness among the citizens and keep it open to express grievances, views, suggestions, compliments and brickbats from the tax payers.

REFERENCES

1. Annual Administration Reports-Part I & II : Corporation of the city of Bangalore, 1950–51 to 1980–81
2. Karnataka Municipal Corporation Act, 1976
3. Report of the Mysore Taxation and Resources Enquiry Committee, 1969
4. Report of the municipal Finance Enquiry Committee, 1975
5. Report of the Karnataka Taxation Review Committee, Part II: Report on Local Finances, 1981
6. M. Nageswara Rao, and S. Rama Rao, Economics of Urban Local Public Sector, Himalaya,1983

7. S. Rama Rao, Finances of Bangalore Municipal Corporation, Allied, 1979
8. M. Nageswara Rao and S. Rama Rao, "Problems and Prospects of Urban Local Governments in Karnataka, Economic Times 22, 23 and 24, March 1977
9. ....., " Urbanisation : Present and Future Urban Public Service system in Karnataka in 2001 AD", Nagarlok," (1), 1979
10. M. Nageswara Rao and B. R. Babu, " Financial Performance of Urban Local Bodies in Karnataka", Paper presented at Karnataka Economic Conference, 25, February 1984, Sandur
11. M Nageswara Rao, Urban and Municipal Bangalore, (Forthcoming)
12. Roy, W. Bahl, "Urban Public Finances in Developing countries : A Case study of Ahmedabad", The world Bank Report, 1975
13. Bangalore on the Move, Civic Affairs Special Issue Decemcer, 1976
14. M Nageswara Rao, Studies in Urban Public Sector. Ashish, 1985

Table 1 : Total Revenue 1950–1981

(Rs. Lakhs)

Year	Total Current Revenue	Opening Balance	Total Revenue
1	2	3	4
1950-52	79.51	7.35	86.86
	(91.5)	(8.5)	
1955-57	110.76	6.60	117.36
	(94.4)	(5.6)	
1960-62	272.74	95.75	371.49
	(73.4)	(26.6)	
1965-67	373.42	134.83	508.25
	(73.5)	(26.5)	
1969-71	670.27	323.94	994.21
	(67.4)	(32.6)	
1975-77	1810.63	693.50	2504.13
	(72.3)	(27.7)	
1979-81	2904.01	851.31	3755.32
	(77.3)	(22.7)	

NOTE : Figures in brackets are percentage to Total (col. 4)

Table 2 : Revenue By Sources 1950–81

(Rs. Lakhs)

Year	Autonomous Sources	External Sources	Debt & Suspense Account	Total Revenue
1	2	3	4	5
1950-52	58.02 (72.9)	7.11 (8.9)	14.38 (18.1)	79.51
1955-57	86.50 (78.1)	13.30 (12.0)	10.99 (9.9)	110.79
1960-62	159.34 (58.4)	79.31 (29.1)	34.09 (12.5)	272.74
1965-67	258.91 (63.3)	65.89 (17.6)	48.62 (13.0)	373.42
1969-71	429.72 (64.1)	145.63 (21.7)	94.93 (14.2)	670.27
1975-77	1238.96 (68.4)	220.55 (12.2)	351.13 (19.4)	1810.63
1979-81	777.96 (26.8)	1460.50 (50.3)	665.55 (22.9)	2904.01

NOTE : Figures in brackets are percentage to Total (Col. 5)

Table 3: Autonomous Sources: Tax Revenue

(Rs. 000s)

Year	Octroi	House/ Property Tax	Lighting Tax	Profession Tax	Advertise-ment Tax	Tax on Animals, Carts, Carriages, Shops, etc	Toll	Total	% to Total Revenue
1	2	3	4	5	6	7	8	9	10
1950–52	1779.9 (58.3)	843.3 (27.6)	168.2 (5.5)	80.6 (2.6)	—	110.8 (3.6)	72.3 (2.4)	3055.1 (52.6)	38.4
1955–57	3062.3 (63.3)	1187.2 (24.6)	239.0 (4.9)	83.4 (1.7)	—	145.9 (3.0)	117.8 (2.4)	4835.6 (55.9)	43.6
1960–62	6756.8 (69.3)	1829.3 (18.9)	684.8 (7.1) (1)	156.2 (1.6)	— (3)	152.7 (1.6)	75.8 (0.8)	9652.6 (60.6)	35.4
1965–67	12650.5 (56.6)	9137.0 (40.9)	104.5 (0.5)	279.6 (1.3) (2)	1.0 (–)	111.3 (0.9)	59.7 (0.3)	22343.6 (86.3)	59.8
1969–71	20696.4 (54.3)	17185.3 (45.1)	—	4.7 (0.0)	181.8 (0.5)	27.8 (0.1)	51.5 (0.1)	38147.0 (88.8)	56.9
1975–77	74444.0 (66.4) (4)	37148.0 (33.2)	—	—	367.0 (0.3)	54.7 (-)	43.6 (–)	112057.3 (90.4)	61.9
1979–81	3442.8 (6.0)	53038.5 (92.9)	—	—	542.9 (1.0)	56.3 (0.1)	13.4 (–)	57093.9 (73.4)	19.7

Notes: Figures in brackets are percent to Total (col. 9) and for col. 9 percent to total Autonomous Revenue.

(1) Lighting Tax (and water rate) was merged with property tax with effect from 1st April 1965.

(2) Profession Tax was taken over by State government with effect from 8th April 1968.

(3) Advertisement Tax was introduced from 1st April 1968.

(4) Only arrears collection as Octroi was abolished with affect from 1st April 1979.

Table 4 : Autonomous Sources : (2) Non-Tax Revenue, Fees, Charges, Fines and Income Derived from Municipal Lands and Properties

(Rs. 000s)

Year	Education	Communication (1)	Public Health	Remunerative Enterprises				Water Supply & Drainage (3)	Other Miscellaneous	Total	% to total Revenue
				Markets and Slaughter Houses	Cart, Bus and Taxi Stands	Land Development and rents (2)	Total (4+6+7)				
1	2	3	4	5	6	7	8	9	10	11	12
1950-51	32.1	39.4	466.1	377.5	6.7	413.0	801.5	1387.8	24.3	2746.9	34.5
	(1.2)	(1.4)	(16.9)	(13.7)	(0.3)	(15.0)	(29.2)	(50.5)	(0.9)	(47.4)	
1955-57	56.0	71.4	675.7	494.4	8.5	314.7	824.1	2153.6	39.8	3814.1	34.4
	(1.5)	(1.9)	(17.7)	(12.9)	(0.2)	(8.3)	(21.6)	(56·5)	(1.1)	(44.1)	
1960-62	62.9	151.9	984.8	679.9	66.4	725.5	1477.0	3262.1	347.5	6281.0	23.0
	(1.0)	(2.4)	(15.7)	(10.8)	(1.1)	(11.6)	(23.5)	(51.9)	(5.5)	(139.4)	
								(4)			
1965-67	470.1	440.8	415.2	1037.9	79.1	571.5	1699.7	300.1	232.7	3547.4	9.5
	(13.3)	(12.4)	(11.7)	(29.3)	(2.2)	(16.1)	(47.9)	(8.5)	(6.5)	(13.7)	
1969-71	99.6	636.5	458.2	1373.2	52.9	755.6	2189.5	—	1448.1	4824.9	7.2
	(2.1)	(13.2)	(9.5)	(28.5)	(1.1)	(15.7)	(45.4)		(30.1)	(11.1)	
1975-77	17.3	2403.9	1003.4	2153.2	87.1	3226.9	5519.5	—	2946.6	11838.4	6.5
	(0.1)	(20.3)	(8.5)	(18.2)	(0.7)	(27.3)	(46.6)		(24.8)	(9.6)	
1979-81	236.8	2706.6	774.3	3317.8	138.4	9786.3	13245.5	—	3741.6	20701.8	
	(1.1)	(13.1)	(3.7)	(16.0)	(0.7)	(47.3)	(63.9)		(18.1)	(26.6)	7.1

Notes : Figures in brakets in col. 2 to 10 are percentage to total (col. 11) and in col. 11 percentage to Autonomous sources.

(1) Includes composition fee, Road cutting charges, etc.

(2) Includes non recurring capital receipts like sale of sites and lands etc.

(3) Including water rate collected with House tax.

(4) Water supply and Drainage works were takenover by State Government (BWSSB) with effect from 1–12–1964.

Table 5 : External Sources of Revenue

(Rs.000s)

Year	Shared/Assigned Taxes		Compensation in lieu of Motor vehicle tax	Grants			Other (1) grants and subsidies	Total (5 to 8)	Loans	Total
	Entertainment Tax	Surcharge on stamp duty		D.A. (3) Grants	Education	Public Health				
1	2	3	4	5	6	7	8	9	10	11
1950-52	271.5 (42.1)	172.5 (26.8)	200.7 (31.1)	—	19.6	—	46.7	66.3 (10.3)	—	711.0
1955-57	571.5 (42.9)	222.2 (16.7)	153.0 (11.5)	—	88.9	23.3	85.2	197.4 (14.8)	185.4 (13.9)	1329.5
1960-62	2279.1 (28.7)	541.7 (6.8)	1256.4 (15.8)	—	44.8	3.7	55.3	103.8 (1.3)	3750.0 (47.3)	7931.0
1965-67	3995.1 (60.6)	1063.0 (16.4)	456.0 (6.9)	—	231.6	50.9	197.1	479.6 (7.3)	575.0 (8.7)	6588.7
1969-71	6533.2 (44.9)	2944.8 (20.2)	456.0 (3.1)	—	2518.6	593.8	883.3	3995.7 (27.4)	600.0 (4.1)	14562.7
1975-77	16537.5 (74.9)	2877.7 (13.0)	456.0 (2.1)	550.0	350.0	1259.3	25.0	2184.3 (9.9)	—	22055.5
1979-81	21869.9 (74.9)	2660.4 (114.9)	82112.0 (2) (56.2)	31875.5	54.40	978.1	—	32908.0 (22.5)	6500.0 (4.5)	146050.3

NOTES : Figures in brackets are percentage to total (col. 11)

1. Includes grants for land development, slum clearance, slum improvement etc.
2. Includes Octroi compensation of Rs. 81656.0 thousands for the year 1979–81.
3. Upto the year 1970–72, D.A. grants were not available separately.

Table 6 : Functional Classification of Expenditure (Current & Capital)

(Rs. 000s)

Year	Management	Education	Communication and Engineering	Public Health and Public Amenities	Remunerative Enterprises & Land Development	Lighting	Water supply	Drainage	Capital (1) payment	Debt and Suspense Account	Total
1	2	3	4	5	6	7	8	9	10	11	12
1950–52	602.2	216.5	1070.2	2069.5	276.9	173.9	1299.4	189.4	216.1	1551.5	7665.1
	(7.9)	(2.8)	(14.0)	(27.0)	(3.6)	(2.3)	(17.0)	(2.5)	(2.8)	(20.2)	(100.0)
1955–57	848.4	277.1	1451.4	2800.0	309.9	400.8	2421.8	409.4	21.0	1585.2	10525.2
	(8.1)	(2.6)	(13.8)	(26.6)	(2.9)	(3.8)	(23.0)	(3.9)	(0.2)	(15.1)	(100.0)
1960–62	1420.4	786.7	3944.6	5099.3	610.4	836.6	4527.5	1821.9	595.3	3380.1	23022.5
	(6.2)	(3.4)	(17.1)	(22.1)	(2.7)	(3.6)	(19.7)	(7.9)	(2.6)	(14.7)	(100.0)
1965–67	2360.5	1955.9	8185.9	10271.3	893.5	1027.9	4405.8	1506.9	420.4	5276.0	36304.4
	(6.5)	(5.4)	(22.5)	(28.3)	(2.5)	(2.8)	(12.1)	(4.2)	(1.2)	(14.5)	(100.0)
1969–71	5606.5	2750.6	19915.6	18828.8	2494.0	1695.4	8037.3	3750.3	2910.3	5726.1	71714.4
	(7.8)	(13.8)	(27.8)	(26.3)	(3.5)	(2.4)	(11.2)	(5.2)	(4.1)	(8.0)	(100.0)
1975–77	14342.6	7046.0	34389.3	42598.3	20799.2	3222.0	22583.2	2620.7	3244.6	29382.3	180228.5
	(8.0)	(3.9)	(19.1)	(23.6)	(11.5)	(1.8)	(12.5)	(1.5)	(1.8)	(16.3)	(100.0)
1979–81	19023.9	9741.5	39083.6	55841.0	6872.1	9295.0	36167.4	3554.6	4343.2	50408.6	23433.0
	(8.1)	(4.2)	(16.7)	(23.8)	(2.9)	(4.0)	(15.4)	(1.5)	(1.9)	(21.5)	(100.0)

NOTES : Figures in brackets are percentage to Total (Col. 12)

1) Payment to Sinking Fund, Repayment of loan and interest payments.

Table 7 : Expenditure on Public Health - Major Heads

(Rs. 000s)

Year	Super-vision	Medical Relief (1)	Preventive Medicine	Food Adult-eration	Conser-vancy and anitation	Birth and Deaths	Public Amenities	TOTAL	
									Of which Salaries and Esta-blishment
1	2	3	4	5	6	7	8	9	10
1950-52	44.0	321.9	181.6	11.7	1203.0	213.3	104.0	2079.5	1335.2
	(2·1)	(15.5)	(18.7)	(0.6)	(57.9)	(10.3)	(5.0)	(100.0)	(64.2)
1955-57	59.7	316.6	215.7	15.2	1747.4	354.1	206.3	2915.0	1966.3
	(2.0)	(10.9)	(7.4)	(0.5)	(59.9)	(12.1)	(7.1)	(100.0)	(67.5)
1960-62	89.5	308.2	326.8	20.9	2943.4	891.7	397.6	4978.1	2970.4
	(1.8)	(6.2)	(6.6)	(0.4)	(59.1)	(17.9)	(8.0)	(100.0)	(59.7)
1965-67	140.3	413.0	1213.1	24.9	6227.2	1408.4	853.2	10280.1	5528.7
	(1.4)	(4.0)	(11.8)	(0.2)	(60.6)	(13.7)	(8.3)	(100.0)	(53.8)
1969-71	222.1	1149.1	1880.9	39.3	10884.4	2296.1	2306.4	18778.3	10346.7
	(1.2)	(6.1)	(10.0)	(0.2)	(58.0)	(12.2)	(12.3)	(100.0)	(55.1)
1975-77	623.8	1198.1	4111.1	122.4	22010.0	7851.4	6010.9	41927.7	29212.0
	(1.5)	(2.9)	(9.8)	(0 3)	(52.5)	(18.7)	(14.3)	(100.0)	(69.7)
1979-81	1134.5	3015.7	5342.1	194.5	34451.2	6901.3	4838.3	55877.6	44365 5
	(2.0)	(5.4)	(9.6)	(0.3)	(61.7)	(12.4)	(8.7)	(100.0)	(79.4)

NOTES : Figures in brackets are percentage to Total (col. 9)

(1) Including Reward for Destruction of Animals.

Table 8: Expenditure on Medical Relief

(Rs. 000s)

Year	RECUURRING							NON-RECURRING		
	Hospital and Dispensaries			Grants to other (2) Hospitals	Ambul.&Hearse Van		Total (cols 2+3+4)	Capital Maintenance	Capital Formation	Total (cols 5+6+7)
	Establishment	Medicines and Materials	Total		Establishment	Total				
1	2a	2b	2	3	4a	4	5	6	7	8
1950-52	52.5	41.5	94.0	110.2	5.0	5.0	209.2	19.7	91.5	320.4
	(16.4)	(13.0)	(29.3)	(34.4)	(1.6)	(1.6)	(65.3)	(6.1)	(28.6)	(100.0)
1955-57	19.5	17.9	37.4	147.3	5.1	9.2	193.9	30.0	87.2	311.1
	(6.3)	(5.8)	(12.0)	(47.3)	(1.6)	(3.0)	(62.3)	(9.6)	(28.0)	(100.0)
1960-62	28.1	11.0	39.1	195.4	17.8	21.4	255.9	44.1	2.5	302.5
	(9.3)	(3.6)	(12.9)	(64.6)	(5.9)	(7.1)	(84.6)	(14.6)	(0.8)	(100.0)
1965-67	46.8	18.8	65.6	223.8	23.0	24.1	313.5	74.2	18.3	406.0
	(11.5)	(4.6)	(16.2)	(55.1)	(5.7)	(5.9)	(77.2)	(18.3)	(4.5)	(100.0)
1969-71	63.9	43.5	107.4	281.8	99.4	182.6	571.8	234.0	218.6	1024.4
	(6.2)	(4.2)	(10.5)	(27.5)	(9.7)	(17.8)	(55.8)	(22.8)	(21.3)	(200.0)
1975-77	495.8 (1)	397.0	872.8	73.8	—	—	966.0	72.3	117.8	1156.1
	(42.9)	(34.3)	(77.2)	(6.3)			(83.6)	(6.3)	(10.2)	(100.0)
1979-81	843.1 (1)	477.1	1320.2	130.4	—	—	1450.6	236.3	1301.6	2688.5
	(28.2)	(16.0)	(44.2)	(4.4)			(48.5)	(7.9)	(43.6)	(100.0)

Notes :—Figures in brackets are percentage to Total (col. 8)

(1) Including Ambulance and Hearse Van

(2) Contribution to Isolation Hospital, Veterinary Hospitals, Local Fund Dispensary and other Institutions.

Table 9 : Expenditure on Preventive Medicine

(Rs. 000s)

Year	Small Pox			Infectious Diseases			Malaria/Mosquito control			Total		
	Establishment	Materials	Total	Establishment	Materials and works	Total	Establishments	Materials & works	Total	Establishment	Materials and works	Total
1	2a	2b	2	3a	3b	3	4a	4b	4	5a	5b	5
1950–52	12.8	17.8	30.6 (16.9)	14.4	73.7	88.1 (48.5)	49.3	13.6	69.2 (38.1)	76.5 (42.1)	105.1 (57.9)	181.6 (100.0)
1955–57	18.5	15.3	33.8 (15.7)	35.1	63.0	98.1 (45.5)	59.2	24.6	83.8 (38.9)	112.8 (52.3)	102.9 (47.7)	215.7 (100.0)
1960–62	22.6	15.1	37.7 (11.5)	94.6	62.3	156.9 (48.0)	95.4	36.8	132.2 (40.5)	212.6 (65.1)	114.2 (34.9)	326.8 (100.0)
1965–67	44.3	—	44.3 (3.7)	165.6	311.7	477.3 (39.3)	224.5	467.2	691.7 (57.0)	434.2 (35.8)	778.9 (64.2)	1213.1 (100.0)
1969–71	34.6	103.9	138.5 (7.4)	218.1	662.0	880.1 (46.8)	696.5	165.8	862.3 (45.8)	949.2 (50.5)	931.7 (49.5)	1880.9 (100.0)
1975–77	689.9 (1,2)	206.0	895.9 (1) (21.8)	—	—	—	2640.7 (3)	574.5	3215.2 (78.2)	3330.6 (81.0)	780.5 (19.0)	4111.1 (100.0)
1979–81	905.9 (1,2)	2241.3	1147.2 (1) (21.5)	—	—	—	3944.4 (3)	250.6	4195.0 (78.5)	4850.3 (90.8)	491.9 (9.2)	5342.1 (100.0)

Notes : Figures in brackets are percentage to Total (col. 5)

(1) Total for preventive Medicines

(2) Of which Rs. 49.5 in 1975–77 and Rs. 110.6 in 1978–81 under National Small Pox Eradication Programme.

(3) Including National Malaria eradication Programme. (Rs. 1234.4 for 1975–77 and Rs. 2042.4 for 1979–81.)

Table 10 : Expenditure on Births and Deaths

(Rs. 000s)

Year	Registration of Births & Deaths	Maternity & child welfare Centres			Burial & Burning grounds	Total (Col. 2, 3 & 4)	Maintenance & repairs of buildings	New works and Purchases	Total	Of which Salaries & establishment
		Establishment	Materials	Total	Establishment					
1	2	3a	3b	3	4	5	6	7	8	8a
1950-52	12.4	90.1	80.4	170.5	11.0	193.9	0.5	18.9	213.3	113.5
	(5.8)	(42.2)	(37.7)	(79.9)	(5.2)	(90.9)	(0.2)	(8.9)	(100.0)	(53 2)
1955-57	12.1	296.9	4.0	301.7	14.1	327.9	4.0	22.2	354.1	323.1
	(3.4)	(83.8)	(0.1)	(85.2)	(4.0)	(92.6)	(1.1)	(6.3)	(100.0)	(91.2)
1960-62	23.1	318.7	174.2	492.9	23.5	539.5	2.0	350.2	891.7	365.3
	(2.6)	(35.7)	(19.5)	(55.3)	(2.6)	(60.5)	(0.2)	(39.3)	(100.0)	(41.0)
1965-67	31.6	578.2	456.1	1034.3	34.5	1100.4	5.4	302.6	1408.4	644.3
	(2.2)	(41.1)	(32.4)	(73.4)	(2.4)	(78.1)	(0.4)	(21.5)	(100.0)	(45.7)
1969-71	110.4	800.7	855.7	1656.4	20.8	1787.6	3.0	505.5	2296.1	931.9
	(4.8)	(34.9)	(37.3)	(72.1)	(0.9)	(77.9)	(0.1)	(22.0)	(100.0)	(40.6)
	(1)	(2)								
1975-77	2157.8	2080.3	773.5	2853.8	21.6	5033.2	101.1	2717.1	7851.4	4259.7
	(27.5)	(26.5)	(9.9)	(36.3)	(0.3)	(64.1)	(1.3)	(34.6)	(100.0)	(54.3)
	(1)	(2)								
1979-81	3475.5	2319.4	632.7	2952.1	25.0	6452.6	143.2	305.5	6901.3	5819.9
	(50.4)	(33.6)	(9.2)	(42.8)	(0.4)	(93.5)	(2.1)	(4.4)	(100.0)	(84.3)

NOTES : Figures in brackets are percentage to total (col. 10)

1. Including maternity and child welfare centres
2. Including Family Planning Centres and India Population Projects.

Table : 11 Expenditure on Conservancy and Sanitation

(Rs. 000s)

Year	Conservancy and Sanitation					
	Establishment	Materials, Maintenance of Carts and Lorries	New purchases	Total (col. 2 to 4)	Capital works (2)	Total
1	2	3	4	5	6	7
1950-52	992.7	172.5	27.8	1193.0	10.0	1203.0
	(82.5)	(14.3)	(2.3)	(99.2)	(0.8)	(100.0)
1955-57	1372.1	209.5	50.8	1632.4	115.0	1747.4
	(78.5)	(12.0)	(2.9)	(93.4)	(6.6)	(100.0)
1960-62	2098.9	264.4	242.6	2605.9	337.5	2943.4
	(71.3)	(9.0)	(8.2)	(88.5)	(11.5)	(100.0)
1965-67	3926.3	197.4	785.2	4908.9	1318.3	6227.2
	(63.1)	(3.2)	(12.6)	(78.8)	(21.2)	(100.0)
1969-71	7325.3	2377.0	385.8	10088.1	796.3	10884.4
	(67.3)	(21.8)	(3.5)	(92.7)	(7.3)	(100.0)
1975-77	18794.7	2306.3	301.0	21402.0	608.0	22010.0
	(85.4)	(10.5)	(1.4)	(97.2)	(2.8)	(100.0)
1979-81	28912.9	5197.7	115.7	34268.3	182.9	34451.2
	(83.9)	(15.0)	(0.5)	(99.5)	(0.5)	(100.0)

NOTES : Figures in brackets are percentage to Total (col. 7)

1. Including breaching of Tanks
2. Include slum improvements, development of compost yards etc.

Table 12: Expenditure on Public Amenities

(Rs. 000s)

Year	Horticulture				Play Grounds Maintenance & Formation	Amusements	Swimming Pools (1)		Library and Reading Rooms	Total	
	Establishment	Maintenance & Materials	New Formation	Total			Establishments	Maintenance & construction			Of which salaries and establishment
1	2a	2b	2b	2	3	4	5a	5b	6	7	7a
1950-52	34.5	24.3	—	58.8	7.2	2.2	5.7	5.1	25.0	104.0	45.3
	(33.2)	(23.4)		(56.6)	(6.9)	(2.1)	(5.5)	(4.9)	(24.0)	(100.0)	(43.6)
1955-57	46.8	54.1	—	100.9	24.2	7.4	9.5	30.9	33.3	206.3	61.0
	(22.7)	(26.2)		(48.9)	(11.7)	(3.6)	(4.6)	(15.0)	(16.2)	(100.0)	(29.6)
1960-62	109.1	36.7	84.2	230.0	57.3	19.5	13.2	33.9	43.7	397.6	139.4
	(27.4)	(9.2)	(21.2)	(57.8)	(14.4)	(4.9)	(3.3)	(8.5)	(11.0)	(100.0)	(35.1)
1965-67	239.9	112.1	169.9	521.9	78.3	50.6	32.5	74.7	95.2	853.2	289.9
	(28.1)	(13.1)	(19.9)	(61.2)	(9.2)	(5.9)	(3.8)	(8.8)	(11.2)	(100.0)	(34.0)
1969-71	633.4	91.7	595.6	1320.7	275.3	72.8	67.4	473.0	97.2	2306.4	719.8
	(27.5)	(4.0)	(25.8)	(57.3)	(11.9)	(3.2)	(2.9)	(20.5)	(4.2)	(100.0)	(31.2)
1975-77	1559.7	221.4	1476.6	3257.7	687.2	85.6	29.1	1872.6	78.7	6010.9	1608.8
	(25.9)	(3.7)	(24.6)	(54.2)	(11.4)	(1.4)	(0.5)	(31.2)	(1.3)	(100.0)	(26.8)
1979-81	2449.4	—	249.4	2698.8	934.4	108.2	143.9	905.6	47.4	4838.3	2614.3
	(50.6)	—	(5.2)	(55.8)	(19.3)	(2.2)	(3.0)	(18.7)	(0.9)	(100.0)	(54.0)

NOTES : Figures in brackets are percentage to Total (col. 7)

1. Including Bathing ghats and Dhobi ghats.

Table 13 : Expenditure on (1) Communications and Engineering and (2) Remunerative Enterprises

(Rs. 000s)

Year	(1) Roads and Communications					Total	(2) Remunerative Enterprises			
	Recurring Expenditure	Non-Recurring					Total Recurring	Maintenance	Capital Works	Total
		Roads and bridges		Others						
		Maintenance	Capital Works	Maintenance	Capital Works					
1	2	3	4	5	6	7	8	9	10	11
1950–52	485.5	324.6	244.0	2.1	14.0	1070.2	117.9	30.6	128.4	276.9
	(45.4)	(30.3)	(22.8)	(0.2)	(1.3)	(100.0)	(42.6)	(11.1)	(46.4)	(100.0)
1955–57	506.8	366.9	538.5	3.0	36.2	1451.4	178.0	32.4	99.5	309.9
	(34.9)	(25.3)	(37.1)	(0.2)	(2.5)	(100.0)	(57.4)	(10.5)	(32.1)	(100.0)
1960–62	845.9	931.1	1626.6	4.3	536.7	3944.6	297.0	28.4	285.0	610.4
	(21.4)	(23.6)	(41.2)	(0.1)	(13.6)	(100.0)	(48.7)	(4.7)	(46.7)	(100.0)
1965–67	1639.5	310.3	5045.1	2.9	1188.1	8185.9	379.7	79.7	343.1	893.5
	(20.0)	(3.8)	(61.6)	(0.1)	(14.5)	(100.0)	(42.5)	(8.9)	(48.6)	(100.0)
1969–71	2854.5	1557.2	14514.2	17.3	972.4	19915.6	638.1	255.4	1600.5	2494.0
	(14.3)	(7.8)	(72.9)	(0.1)	(4.9)	(100.0)	(26.6)	(10.2)	(64.2)	(100.0)
1975–77	6804.7	2758.1	23858.5	66.0	902.0	34389.3	371.6	593.4	19834.2 (1)	20799.2
	(19.8)	(8.0)	(69.4)	(0.2)	(2.6)	(100.0)	(1.8)	(2.9)	(95.4)	(100.0)
1979–81	11015.5	3046.6	21196.3	—	3825.0	39083.6	876.9	589.2	5406.0	6872.1
	(28.2)	(7.8)	(54.2)		(9.8)	(100.0)	(12.8)	(8.6)	(78.7)	(100.0)

NOTES : Figures in brackets are percentage to totals.

(1) Includes construction of Public utility Building and Jayanagar shopping complex etc.

Table 14: Expenditures on (1) Lighting (2) Water Supply and (3) Drainage

(Rs. 000s)

Year	(1) Lighting				(2) Water Supply and Meters				(3) Drainage			
	Establi-shment	Power charges	Maintenance & Repairs	Total	Establi-shment	Maintenance & Repairs	Capital Works	Total	Establi-shment	Maintenance	Capital Works	Total
1	2	3	4	5	6	7	8	9	10	11	12	13
1950–52	—	169.1	4.8	173.9	61.5	1219.4	18.5	1299.4	34.8	71.4	83.2	189.4
1955–57	—	395.9	4.9	400.8	75.2	2255.3	91.3	2421.8	89.0	165.9	154.5	409.4
1960–62	13.4 (1)	823.2	—	836.6	128.5	3055.5	1343.5	4527.5	128.5	67.1	1626.3	1821.9
1965–67	19.5	976.0	32.4	1027.9	21.2 (2)	4375.1	9.5 (3)	4405.8	85.8	151.8	1269.3	1506.9
1969–71	56.1	1004.4	634.9	1695.4	73.6	7753.5	210.2	8037.3	98.2	427.3	3224.8	3750.3
1975–77	255.5	935.0	2031.5	3222.0	25.0	23263.1	—	22583.2	—	238.3	2382.4	2620.7
1979–81	352.3	7079.1	1863.6	9295.0	—	36167.4	—	36167.4	—	258.6	3296.0	3554.6

NOTES : 1. Up to the year 1961 electricity Board was entrusted with the maintenance of street lighting.
2. Since water supply and Drainage works were taken over by BWS & SB
3. Includes amount paid to BWSSB for (1) water consumption charges of Corporation and (2) free allowance to private consumers.

Table 15: Expenditure on (1) General Management and Revenue Collection and (2) Education

(Rs. 000s)

Year	(1) General Management and Revenue collection					(2) Education					
	Establish-ment	Others (1)	Capital Mainte-nance	Capital Works	Total	Establish-ment	Materials Equip-ment	Others (2)	Mainte-nance	Capital Works	Total
1	2	3	4	5	6	7	8	9	10	11	12
1950-52	348.9	148.6	11.8	17.6	602.2	142.8	17.6	30.5	2.5	23.1	216.5
	(57.9)	(24.7)	(2.0)	(2.9)	(100.0)	(65.9)				(10.7)	(100.0)
1955-57	386.1	254.4	6.6	20.2	848.4	220.1	10.2	26.7	5.6	14.5	277.1
	(45.5)	(29.9)	(0.8)	(2.4)	(100.0)	(79.4)				(5.2)	(100.0)
1960-62	659.7	442.2	14.5	117.5	1420.4	494.0	54.5	58.5	8.1	168.6	786.7
	(46.4)	(31.1)	(1.0)	(8.3)	(100.0)	(62.8)				(21.4)	(100.0)
1965-67	1156.7	747.0	12.1	141.3	2360.5	1254.3	54.3	59.2	19.1	569.0	1955.59
	(49.0)	(31.6)	(0.5)	(6.0)	(100.0)	(64.1)				(29.1)	(100.0)
1969-71	2001.2	1708.2	44.5	379.9	5606.5	2003.9	39.1	159.7	81.1	466.8	2750.6
	(35.7)	(30.5)	(0.8)	(6.8)	(100.0)	(72.9)				(16.9)	(100.0)
1975-77	5582.3	5703.8	79.1	1340.1	14342.6	5236.9	108.1	42.9	135.9	1522.2	7046.0
	(38.9)	(39.8)	(0.6)	(9.3)	(100.0)	(74.3)				(21.6)	(100.0)
1979-81	9607.8	5201.1	749.7	842.4	19023.9	8240.6	226.9	396.2	153.2	724.6	9741.5
	(50.5)	(27.3)	(3.9)	(4.4)	(100.0)	(84.6)				(7.4)	(100.0)

NOTES : Figures in brackets are percentage to Totals

(1) Pensions and other benefits.

(2) Grants to other institution, student and teachers benefits. etc.

Table 16: Overall Budgetory Position 1950–81

(Rs. Lakhs)

Year	Total Revenue	Total Expenditure	Closing Balance (col. 2–col. 3)	Total Revenue
1	2	3	4	5
1950-52	86.9	76.7 (88.3)	10.2 (11.7)	6.4
1955-57	117.4	105.3 (89.7)	12.1 (10.3)	8.5
1960-62	371.5	230.2 (62.0)	141.3 (38.0)	13.8
1965-67	508.3	363.0 (71.4)	145.2 (28.6)	25.2
1969-71	994.2	717.2 (72.1)	177.0 (17.8)	45.2
1975–77	2504.1	1802.3 (72.0)	701.8 (28.0)	118.7
1979–81	3755.3	2343.3 (62.4)	1412.0 (37.6)	186.1

NOTE : Figures in brackets are percentage to Total Revenue (col.2)

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